AGRICULTURAL ENGINEERING

DECEMBER • 1952

Challenging New Horizons in Farm Machinery Development *K. W. Anderson*

Current Research and Developments in Farm Structures *Wallace Ashby*

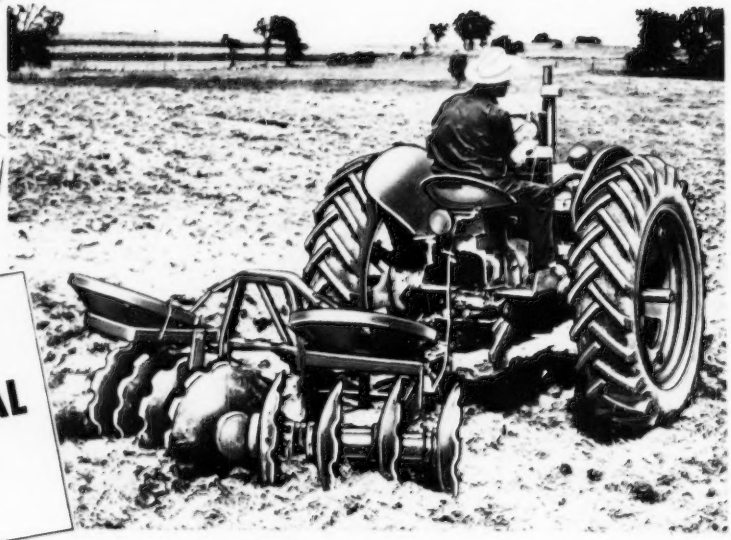
Developing a Tractor-Mounted Castor Bean Harvester *E. W. Schroeder and I. F. Reed*

Rewards of a Design Career in the Farm Machinery Field *L. H. Skromme*

Forced vs. Natural Ventilation in Poultry Houses *W. J. Promersberger and R. L. Bryant*

THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

When Does 1=4?



NEW CASE EDUCATIONAL MOVIE

Shows You!

Here is a four-way teaching impact! New movie with companion poster, study guide, and take-home booklet tell farmers and farm youth how to make *one* acre of renovated pasture pour out all the meat, milk, wool, and cash that four unimproved acres now produce. This new quartet of Case educational materials shows how to test and treat soils—renovate old sod—establish rich new growth—how to use for immediate and long-time high income. The movie is entitled "One Equals Four," and like all Case educational movies is 16 mm., in full color and sound. Non-commercial; runs 22 minutes. Film is loaned, printed matter furnished without charge to teachers, agricultural leaders, farm and civic clubs, other responsible persons and groups. Film loans should be requested as far ahead as possible, and alternate date specified if feasible.

60 EDUCATIONAL HELPS

As its contribution to a prosperous, enduring agriculture, the Case Company has prepared some sixty educational items all free to users. These include motion pictures, sound slide films, posters, study guides, booklets, and charts on a long list of subjects on conservation and other profitable farming practices. Be sure you have the latest Case visual education materials catalog, "Visual Aids to Modern Farming." It describes each item and tells how to order. Be sure to get your catalog and all materials through your nearest Case dealer or branch house. J. I. Case Co., Racine, Wis.

CASE

No ONE chain serves every purpose

What's your chain requirement?

Cotton pickers now move through the fields at high speeds. This well-known model, like several others, is designed with Link-Belt Precision Steel Roller Chain & Sprockets.

Match it exactly from LINK-BELT's complete line

WHETHER it's a high-hp, heavy-impact cylinder drive . . . or relatively slow-speed conveying service—you can get the *one* chain that best meets your needs from Link-Belt's complete chain line. Our agricultural chain engineers will be glad to sit down with you and your designers—help you work out the right chain for your requirements. And, remember—a chain bearing the Link-Belt double-arrow trademark is your guarantee of longer chain life.

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12,791

Typical chains from the complete LINK-BELT line

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Class 400 Pintle chain—cast links with closed pin joint, for light conveyor, elevator or drive duty.

Double-Pitch Precision Steel Roller Chain, for conveyor and power transmission applications.

Precision Steel Roller Chain, standard pitch, combines high horsepower with light weight.

AGRICULTURAL ENGINEERING

Established 1920

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AGRICULTURAL ENGINEERING is regularly indexed by Engineering Index, and by Agricultural Index.

Volumes of AGRICULTURAL ENGINEERING, in microfilm form, are available (beginning with Vol. 32, 1951), and inquiries concerning purchase should be directed to University Microfilms, 313 N. First St., Ann Arbor, Mich.

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TO OUR READERS: Advertisers in this issue present their products and services for your scrutiny, with confidence in their engineering merit and capacity to meet the requirements for which intended, and with confidence in your appreciation of these contributions to engineering progress in agriculture.

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POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

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A report to you about men and machines that help maintain International Harvester leadership

IH ENGINEERS

cut equipment investment and farm work hours with this dual purpose

McCormick FIELD HARVESTER

High production costs and a shortage of manpower are problems farmers must solve to earn maximum profits. The new, large-capacity McCormick No. 20-C Field Harvester offers farmers who feed hay or silage a sound solution to both of these problems. IH engineers helped make this possible through research and product design.

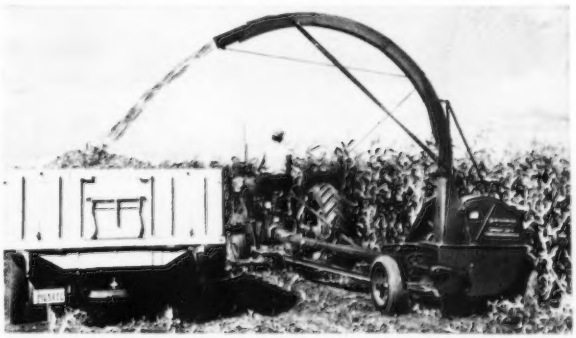
This dual-purpose machine, which harvests hay and row-crops by merely changing attachments, reduces the farmers' machine investment. One-man operation saves money by reducing the size of the harvest crew. A daily capacity of 250 tons—enough to fill three 14 x 28 silos—makes it possible to harvest crops at peak feeding value.

IH engineers provided such features in the new McCormick field harvester as the overrunning clutch which allows the flywheel to rotate freely when power is stopped. This clears out chopped material—saves time loss due to clogging. They also provided nine different lengths of cut to safeguard the storage and feeding quality of practically any crop.

These and many other IH engineering refinements help to make field harvesting of both forage and silage crops more *practical and profitable* for thousands of farmers.

Chops hay and grass silage. Pick-up hay attachment handles any windrowed crop such as green hay, cured hay, or straw.

Four-bolt fastening of pick-up and row-crop attachments makes it easy to adapt the harvester for either hay or row-crop work in 15 to 20 minutes.



Harvest standing row crops like corn, sorghum, or similar crops. Wide gathering sheets with low-riding points get *all* the crop.

IH engineering teamwork produced the big-capacity, dual-purpose McCormick field harvester. IH research, engineering, and manufacturing men are constantly pooling their time and talent to solve farm problems—to provide equipment that makes farm work easier and the farmer's time more productive!

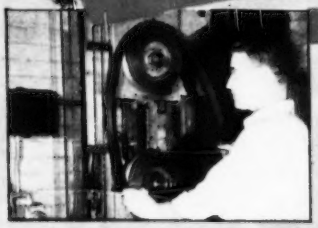
INTERNATIONAL HARVESTER

International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors . . . Motor Trucks . . . Crawler Tractors and Power Units . . . Refrigerators and Freezers—General Office, Chicago 1, Illinois

DURKEE ATWOOD V-BELTS

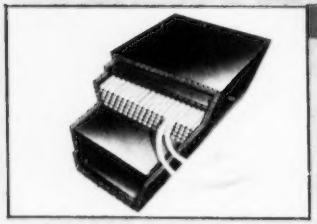
EXTRA VALUES

FOR USERS OF INDUSTRIAL V-BELTS



VERTICAL MATCHING ASSURES EQUAL POWER TRANSMISSION

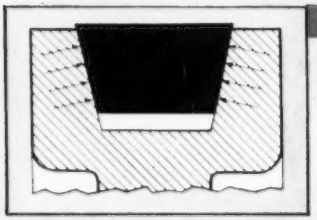
Durkee-Atwood's new vertical V-belt matching machines eliminate the "sag" error always present when V-belts are matched on horizontal matching equipment. Calibration of true running length assures equal power transmission from all belts on multiple belt drives. The machines also test for vibration and possible internal imperfections.



DU PONT CORDURA® RAYON MULTIPLE CORD CONSTRUCTION

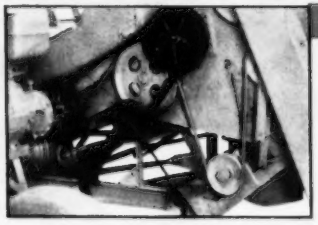
High-tenacity Cordura® rayon cords give Durkee-Atwood Industrial V-Belts longer life, less stretch, and greater shock resistance. Use of this revolutionary new cord material is another one of the reasons why D-A Industrial V-Belts are guaranteed to satisfy on any drive.

®Trademark E. I. Du Pont De Nemours & Co., Wilmington, Del.



STRAIGHT SIDEWALLS—FULL GROOVE CONTACT

Durkee-Atwood V-Belts are manufactured with straight sidewalls to maintain full groove contact at all times giving positive drive action. Straight sidewalls reduce slippage and assure smooth, efficient power transmission. The load is distributed evenly over the entire thickness of the belt giving it longer life.



FIELD-TESTED AND APPROVED

Durkee-Atwood V-Belts are delivering the power for more and more manufacturers of agricultural equipment. Durkee-Atwood attention to details both in adherence to specific engineering standards and to specific delivery requirements makes Durkee-Atwood your best possible source for your V-belt requirements.

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MINNEAPOLIS 13, MINNESOTA

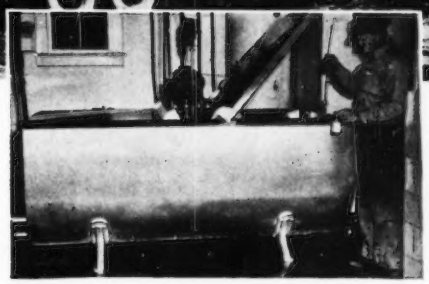
DURKEE ATWOOD V-BELTS

DA PRODUCTS

Form No. 539

THIS TRUCK'S 3500 GALLON TANK (insulated) carries bulk milk from farm to city dairy. To maintain purity of contents... and for permanence... it is made from chromium-nickel stainless steel.

AT THE FARM... new milk moves via stainless steel milk lines or buckets into a stainless steel self-refrigerating tank, as shown below, where an agitator mixes it with milk cooled during the previous night. Contents of milkhouse tank are pumped directly into tank truck, and sped to dairy.



STAINLESS PLAYS IMPORTANT ROLE IN NEW SYSTEM

Of Direct Farm-To-Processor Bulk Handling of Milk!

"Something *new* has been added" to the six billion dollar milk industry...

A *new system*... in which chromium-nickel stainless steel contributes to quicker handling, less drudgery, better cooling, and above all, to higher and more uniform quality of product. Simplicity of the system is shown by the illustrations.

Appreciating its many advantages, United States Steel Company, a leading producer of stainless steels, has supplied these corrosion-resisting metals to many fabricators of milk tank trucks, farm bulk milk tanks and allied equipment.

Austenitic chromium-nickel stainless steels are highly resistant to food acids and atmosphere, as well as to most organic and a great many inorganic chemicals. The mechanical properties of stainless steels permit cutting bulk and deadweight without sacrificing strength or durability. Another all-important advantage is that they are easy to clean, and to keep clean.

Leading steel companies produce austenitic chromium-nickel stainless steels in all commercial forms. A list of sources of supply will be furnished on request.

At the present time, the bulk of the nickel produced is being diverted to defense. Through application to the appropriate authorities, austenitic stainless steels are obtainable for many end uses in defense and defense supporting industries. Counsel and data on alloys containing nickel, for your present production or future projects, are yours for the asking. We invite your inquiries.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

This Homemade PILE DRIVER solves fence post problem

The Hoovers' pile driver puts in new gatepost in a matter of minutes. Bud Hoover explains operation to Texaco Man C. H. Davis. Bearings of pile driver and tractor are lubricated with Marfak because this famous lubricant won't jar off, dry out or cake up — and it lasts longer.

Enables Two Men to Put in a Mile of Posts in 8 Hours

Charles C. Hoover and his sons, Bud and Claud, operate a 2,000-acre ranch near Medford, Oregon. Claud has made many labor-saving devices, including the pile driver shown above, mounted on a hydraulic lift.

Materials used were the rear end and transmission of an old Model A Ford and some scrap iron. The weight that drives the posts is 360 lbs. and drops 20 times a minute. This machine eliminates posthole digging and manual labor.

The Hoovers have been using Texaco Products for 20 years and say there are none better. The Hoovers have a fine herd of 400 registered Herefords and 300 calves.

Dependable neighborly service is what farmers get from their Texaco Men. Texaco Man Gordon Ebbert of Colfax, Washington, is having a friendly chat with J. Walter Daubert who farms 478 acres at Endicott. Mr. Ebbert has just delivered a tankful of Fire-Chief, the gasoline with superior *"Fire-Power"* for low-cost operation.

Walter Sylvester (right) near Battle Creek, Michigan, uses Havoline Motor Oil because it practically eliminates wear. It exceeds Heavy Duty requirements, is ideal for Diesel or gasoline engines and equipment using L-P gas as fuel. Harold Kindy (left), a neighbor, is a visitor. Texaco Man Charles Gripe serves Mr. Sylvester.

W. E. (Bill) Stephens of Sheldon, Texas, gives his tractor the protection it needs — Texaco PT, permanent type anti-freeze. One dose lasts all winter; it won't boil away, and it gives anti-rust protection. Texaco Man T. I. Trahan of Houston looks on.

This drama of a boy's efforts to raise a champion hog shows how top breeds are judged. Takes you to Indiana State Fair. Ask your Texaco Man for time and place of showing. Bring your family. No cost. Free prizes.

TEXACO

THE TEXAS COMPANY

TUNE IN . . . Metropolitan Opera broadcasts every Saturday afternoon. See newspaper for time and station.

IT PAYS TO FARM WITH TEXACO PRODUCTS

Proudly your 50 for Fifty Years

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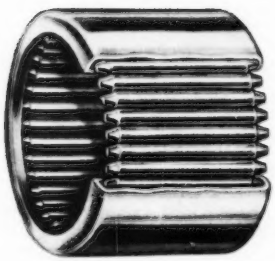
tight quarters are no problem



Torrington Needle Bearings have smaller OD in relation to rated radial load capacity than any other type of anti-friction bearings.

In many products, compact Needle Bearings allow reductions in size and weight of housings and related assemblies. In others, they permit the use of larger, stronger shafts without increasing housing bores.

Whatever *your* space problem, it will pay you to investigate the combination of high capacity and small OD offered by Torrington Needle Bearings. Our engineers will be glad to assist you.

THE TORRINGTON COMPANY
Torrington, Conn. South Bend 21, Ind.
District Offices and Distributors in Principal Cities of United States and Canada

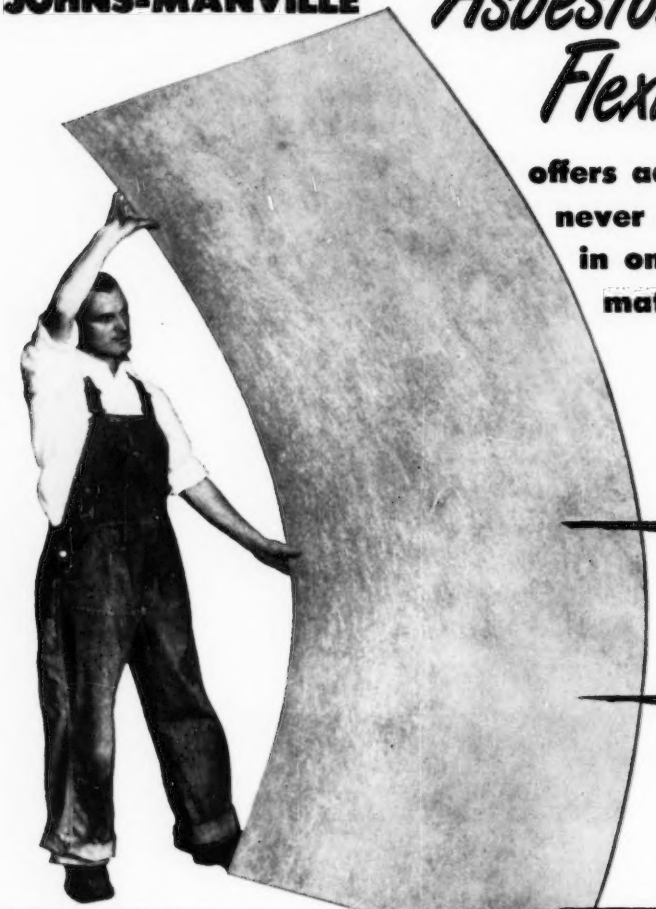
TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Tapered Roller • Straight Roller • Ball • Needle Rollers

JOHNS-MANVILLE

Asbestos Flexboard

offers advantages never before combined in one building material.



One man can handle the big sheets

Easy to nail

Easy to handle

Strong and tough

Asbestos Flexboard answers a thousand building needs

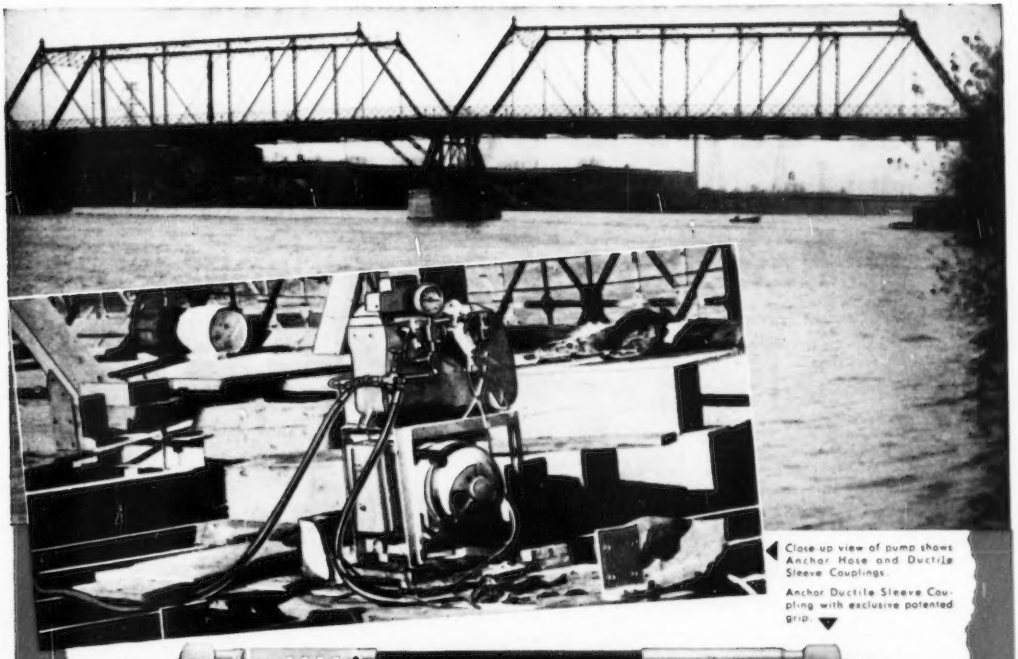
for the home, for the factory, for the farm!

IT'S DIFFICULT to appreciate the many advantages of Asbestos Flexboard until you have used it. It wears like stone, it's light in weight, and it can be flexed to fit curved surfaces. On the job, ordinary hand tools are used to work Flexboard and customary construction methods are followed. It can be applied horizontally or vertically, and can be nailed close to the edge without drilling.

Made of asbestos and cement, Flexboard is fireproof, won't rot, rust or corrode, resists rats and termites. Large 4′ x 8′ Flexboard sheets come in 3 thicknesses—⅛″, 3/16″, and ¼″. Flexboard has an attractive stone-grey color with a smooth hard surface that needs no other finish. As soon as it is in place, it is ready for years of maintenance-free service.

For more information about Asbestos Flexboard, write Johns-Manville, Box 60, New York 16, N.Y.

JM PRODUCTS **Johns-Manville**



Close up view of pump shows Anchor Hose and Ductile Sleeve Couplings.

Anchor Ductile Sleeve Coupling with exclusive patented grip.

Bridge lifting job handled easily—

with high-pressure ANCHOR hose and ductile sleeve couplings

MINNEAPOLIS . . . Here's a difficult job recently performed on the Broadway Avenue Bridge. Four spans across the upper Mississippi, each weighing approximately 250 tons, were raised to provide 19 ft. additional clearance at one side of the river for the passage of boats and sloped to the existing level on the other side. Anchor Hose and Ductile Sleeve Couplings, well-known for dependability and safety, were used for transmitting the required high hydraulic pressures to the twenty 4" jacks under each span. The use of hydraulic hose and the principle of hydraulic lifting made it possible to do this unusual job.

Tough jobs like this point up the superiority of Anchor factory-assembled couplings and hose. The positive seal eliminates leakage even under extreme pressures. The exclusive, patented Anchor grip makes the coupling virtually a part of the steel reinforcing wire of the hose — prevents blow-offs.

These complete high-pressure hose assemblies are exactly tailored to your particular job. They assure a wide safety margin and fewer hydraulic equipment breakdowns.

Typical uses of Anchor's complete range of flexible hose lines and couplings include high-pressure riveting, road machinery, coal mining equipment, machine tool applications, farm tractors, railroads, oil field machinery, and lubrication.

Find out how these time-, trouble-, and money-saving hose assemblies can improve your product — *Attach coupon to your letterhead and mail TODAY!*

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Dept. AE-122, Libertyville, Illinois

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Company.....
Company Address.....
City..... (.....) State.....
D-9

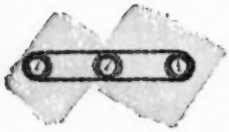
If Your Design Problem

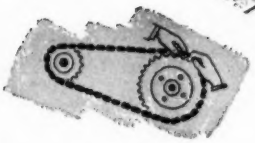
design flexibility dependability

low initial cost

low overall cost

long centers short

 positive timing heat

ease of installation  long life

Chain Is Your Answer

Yes, chain will solve any of these problems in both drive and conveyor service. The important point is to be sure you select the best chain to do the job. That's why so many agricultural machinery designers make their selections from the complete Chain Belt line.

In the complete Chain Belt line there are literally hundreds of sizes and types of chain . . . but only one can be the *best* chain for your particular application. For example: for a high speed drive, Baldwin-Rex® Roller Chain is probably most efficient. For where speeds are slower and loads

REX

BALDWIN-REX®

Chain

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CHICAGO • CINCINNATI • CLEVELAND • DALLAS
DENVER • DETROIT • EL PASO • HOUSTON
INDIANAPOLIS • JACKSONVILLE • KANSAS CITY
LOS ANGELES • LOUISVILLE

Involves...

moderate, Rex Steel Detachable Chain or Rex Cast Detachable Chain is probably the answer. Where speeds are slow but a finished steel chain desirable, Baldwin-Rex Double Pitch Roller Chain is a likely choice.

Our Rex Field Sales Engineers are specially trained to help you with your chain selection problems. For more help, call your nearest Chain Belt branch office or write to Chain Belt Company, 4680 W. Greenfield Ave., Milwaukee 1, Wisconsin.

Belt COMPANY
OF MILWAUKEE

MIDLAND, TEXAS • MILWAUKEE • MINNEAPOLIS
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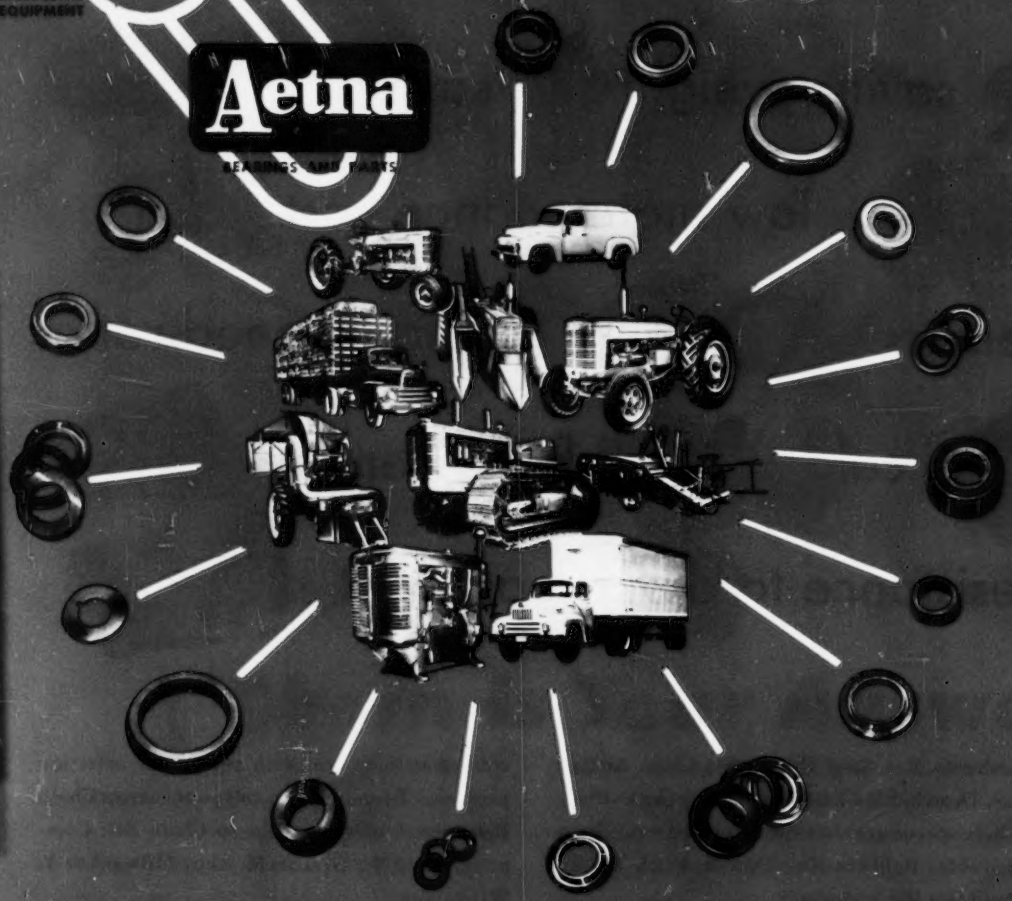
Chain Belt Company 52-506
4680 W. Greenfield Ave.
Milwaukee 1, Wis.
Gentlemen:
My chain selection problem is.....
.....
Please send me appropriate literature.
Name.....
Company.....*Dept.*.....
Address.....
City.....*State*.....

INTERNATIONAL HARVESTER EQUIPMENT

IN STEADY COMPANY FOR 27 YEARS

Aetna

BEARINGS AND PARTS



Of the many evidences of Aetna quality, none is more impressive than the roster of famous manufacturers featuring Aetna products as their standard or recommended equipment. That is why we are especially proud to point to our 27-year supplier-relationship with the World's largest producer of farm implements . . . International Harvester.

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4835

How to plan a farm for comfort...and profit

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Steel buildings can be put close together, with covered area-ways between buildings that keep the farmer protected from rain and snow. So while he still spends about 60% of his winter working hours in and around the barnyard, most of it is under cover.

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What's more, with prefabricated steel buildings a farmer can improve his efficiency by changing his layout as his needs change. He can economically enlarge or relocate these buildings with regular farm labor, using ordinary tools.

Many manufacturers use Armco ZINCGRIP in the fabrication of steel buildings. This steel has a special zinc coating that doesn't flake or peel off when the panels are formed. If the buildings are to be painted, Armco ZINCGRIP PAINTGRIP is used because it is Bonderized at the mill to take and hold paint longer.

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THE ARMCO INTERNATIONAL CORPORATION, WORLD-WIDE

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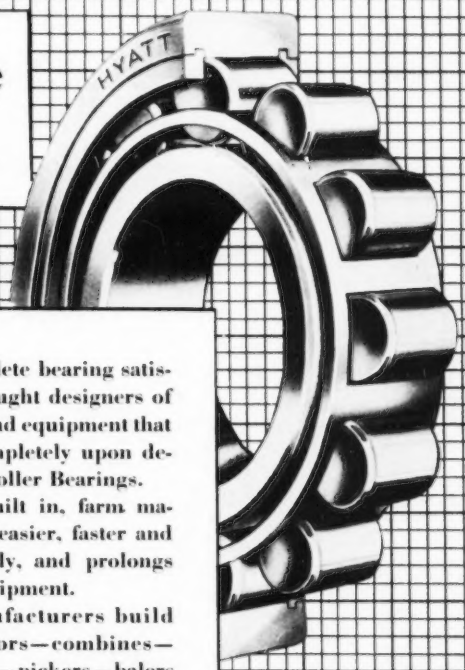

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With Hyatts built in, farm machinery operates easier, faster and more economically, and prolongs the life of the equipment.

Leading manufacturers build Hyatts into tractors—combines—spreaders—drills—pickers—balers—spray-pumps and other farm machinery. These leaders in farm machinery know that Hyatt has been making better bearings for sixty years, and they want their customers to have the best.

The best buys in farm machinery have Hyatts built in. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

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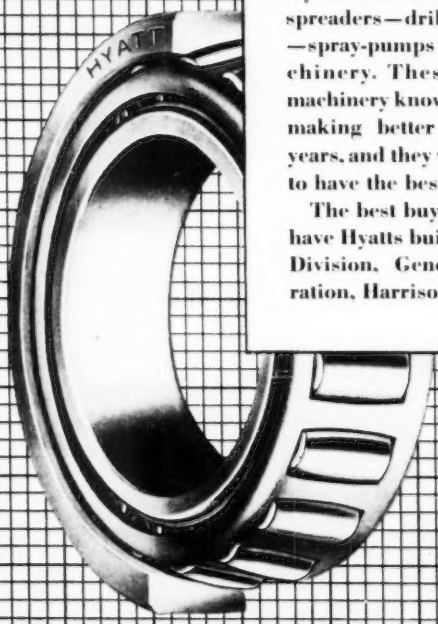

HYATT
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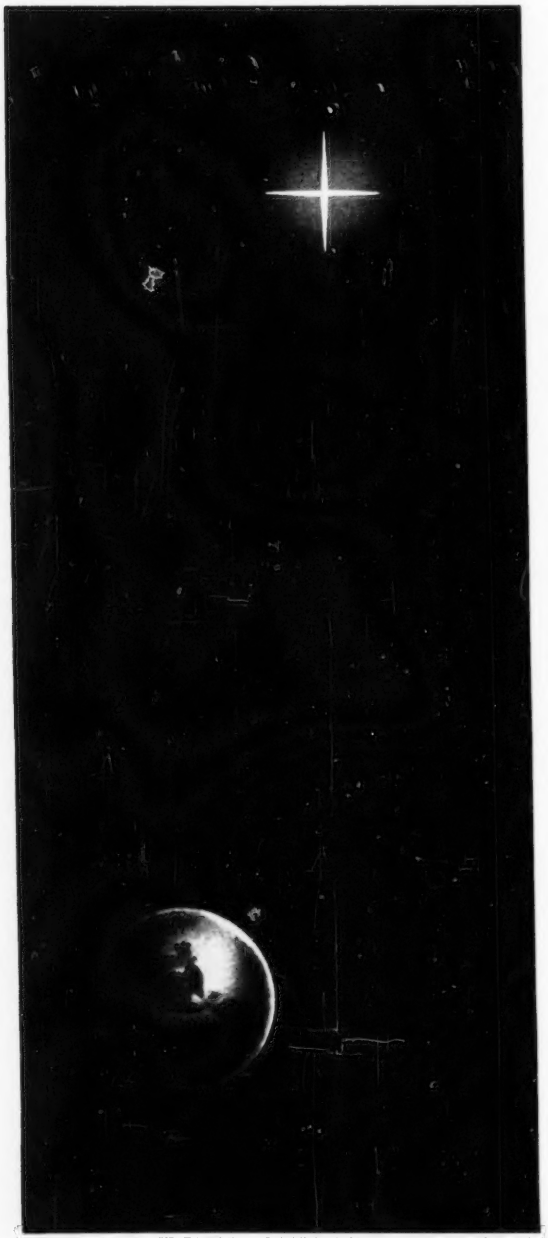
ROLLER BEARING

HYATT ROLLER BEARINGS

The Christmas Star Still Shines...



There's a brightness touches earth at Christmas that Science can't explain.

It speeds across a universe to pierce the darkest clouds of Gloom...to dispel the deepest shadows of Despair.

Irrepressible, it penetrates Oppression's thickest walls...invades Misfortune's deep and dusky dungeons with its rays.

Radiant, its warmth rekindles smoldering coals of Charity...and lends new spark to dying fires of Hope.

Broadbeamed, it lights the earth from sea to sea...and finally finds reflection in the minds and hearts of men.

True, Science can't explain it...saying all the stars are counted...every sparkle charted to a pinpoint.

But all who've seen its beauty...known its brilliance...know it truly is the self-same star the Magi saw...visible still at Christmas time... through a telescope called Faith.

JOHN DEERE
Moline, Illinois

Quality Farm Equipment Since 1837

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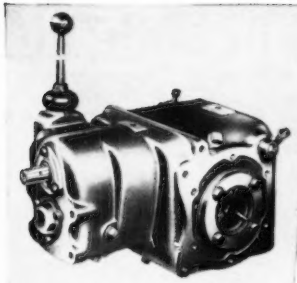

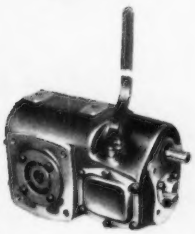

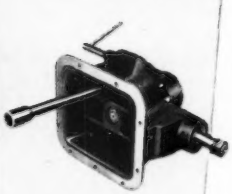

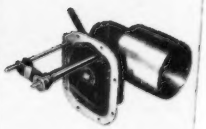

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Picture courtesy BROOME G. L. F. ELEVATOR

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"Since installing STOW flexible shafting on our bulk feed delivery units, we have lost no time due to breakdowns and have had no maintenance problems in over five months of continuous service", says Mr. Joseph Collins, manager, Broome G.L.F. Elevator.

This STOW flexible shaft application replaces a universal joint series which would not stand up under the rugged conditions to which it was subject during deliveries to farms. Primary cause of the failure, according to Mr. Collins, was the steep angles through which the universal joints had to operate. Prior to the installation of STOW flexible shafting, Broome G.L.F.'s grain delivery units suffered frequent breakdowns, each of which involved three or four-hour delays and upped delivery costs.

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WRITE TODAY for your FREE Torque Calculator and Bulletin 525 containing complete data on STOW flexible shafting. No obligation, of course.

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This is a film of scope and beauty, dignifying the most basic occupation of man. It pictures great advances made in agriculture and the bright horizons ahead ... horizons where the gleam of aluminum is seen increasingly, as farm buildings develop into more efficient farm tools.

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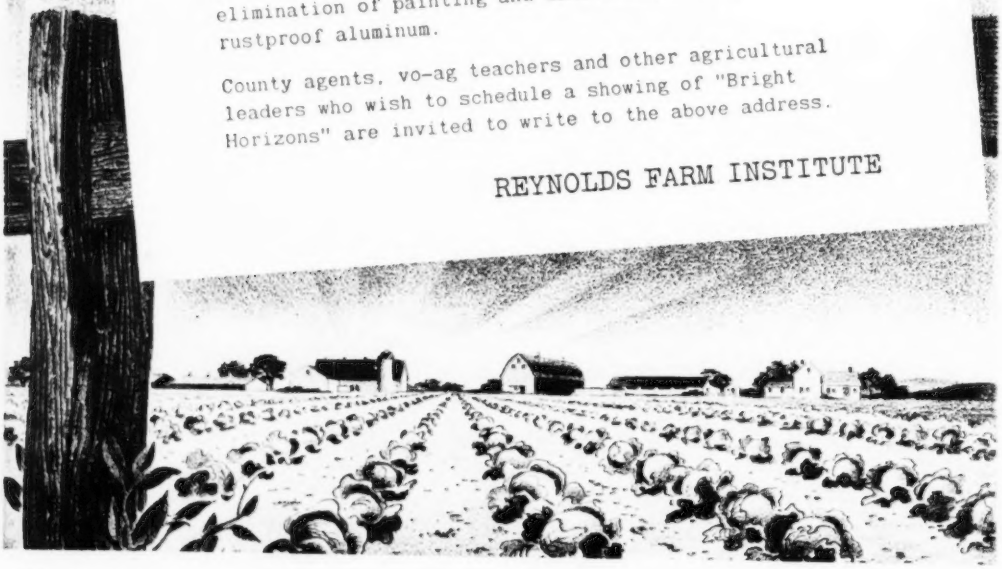
County agents, vo-ag teachers and other agricultural leaders who wish to schedule a showing of "Bright Horizons" are invited to write to the above address.

REYNOLDS FARM INSTITUTE



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EDITORIAL

Manpower Policy

DEFENSE Manpower Policy No. 8 was published early in September by the Office of Defense Mobilization. In brief, it calls for cooperation of all governmental and private agencies, organizations, and individuals in (1) recognizing an existing and prospective continuing shortage of scientific and engineering personnel, (2) making most effective use of such trained personnel as is available, considering individual abilities, the needs of defense agencies, and needs for a strong supporting civilian economy, and (3) encouraging increased numbers of young people with appropriate aptitudes to train for subprofessional, professional, and advanced professional careers in science or engineering.

It is interesting to note that this pronouncement recognizes, as applying to the over-all shortage and effective use of technical personnel, most of the conditions and principles brought to its attention last spring as applicable to the most effective use of agricultural engineers. They were embodied in a summary of a prepared statement entitled "Potential Contributions to National Defense by the Agricultural Engineering Profession." This statement was drafted by the ASAE Committee on Defense Activities, approved by the Council of the Society, and presented to the ODM. Similar representations were undoubtedly made to the ODM by other professional groups.

The policy statement further recommends specific measures to be taken by various interested groups to alleviate the shortage of technical manpower. The three specifically recommended for action by professional associations of scientists and engineers concern (1) recruiting additional students, (2) studying professional requirements, resources, and employment conditions, and (3) cooperating with educational institutions concerning possible improvements in curriculums, teaching methods, and utilization of teaching facilities. The ASAE and various of its committees have given or are giving attention to all three of these matters. A careful check might be made, however, to see whether there is anything further the Society could do along these lines.

The Increasing Use of Engineers

A TABULATION of engineers per 100,000 workers in industry shows a consistent increase from 344 in 1890 to 1550 in 1950.

By way of comparison, approximate figures indicate that there are currently about 80 agricultural engineers available per 100,000 workers in the industry of agriculture.

At the rate of use of engineers current in other industries, agriculture in the United States would require the services of 77,500 agricultural engineers, rather than the 4,000 it now has, and the crop acreage per agricultural engineer would be about 4,500, rather than 85,000 as at present.

The full significance of these figures is not apparent at this writing. They are presented as a matter for thought and for such tentative conclusions only as may contribute to a further understanding of the engineering service which agriculture can use to advantage.

It might appear on the surface that agriculture is either far behind other industries in utilizing engineers, or that agriculture uses them far more effectively than do some other industries. Both may be partially true.

There are factors contributing to a somewhat lower requirement for engineers in agriculture than in some other industries. For example, the basic design of agricultural products has been provided by nature; biologists handle a major part of agriculture's product development and improvement work; and much of agriculture's output is passed along to processing industries for the handling of engineered operations involved in putting the products in condition for use by the ultimate consumer.

Further, the quantity production of more or less standardized types of farm equipment; centralized and cooperative research; and extension work by both industrial and public service agencies have contributed to the over-all effectiveness of agricultural engineers.

On the other hand, some of agriculture's engineering problems are greater than commonly encountered in other industries. Its productivity is influenced by a well-known wide range of physical variables in the weather and soil environment, and in the physical properties and responses of biological materials. Increasing scientific knowledge points toward the desirability of dealing with agriculture's tremendous tonnages and energy requirements with increasing precision and closer tolerances in time, mass, weight, volume, pressure, dimension, temperature, proportion and biochemical action. Engineering the world's basic food production involves engineering the physical environment and treatment of the microscopic productive living cell.

Agriculture does call for an increase in engineers in proportion to its strength in production workers, for the further improvement of its living and production facilities, and for increased efficiency in the selection, organization, and application of those facilities. It calls for the further engineering of biological productivity and all related human activity as practiced by farmers. More agricultural engineers per 100,000 agricultural workers can mean more and better and lower cost food for all, as well as better living and increased satisfactions for farmers.

Antibiotics for Crops

ACCORDING to a recent preliminary report, some antibiotics have shown promise of usefulness in increasing the productivity of farm crops as well as livestock. In one test the dry-weight yield of corn is reported to have been doubled. Whether the check plot was 40-bushel corn or 100-bushel corn was not stated.

The use of antibiotics in livestock feeds has thus far proven of some interest to agricultural engineers in connection with farm feed storage, mixing, and feeding practices and equipment. Resulting increased productivity may have influenced livestock handling equipment requirements to some degree. Antibiotics for crops might prove of considerably greater significance to agricultural engineers.

One indicated experimental use of one ounce of terramycin and penicillin in 7000 gallons of water suggests a proportioning, mixing, and application problem to be solved in developing the application to farm crops. The inoculation of irrigation water might prove a further shot-in-the-arm to the practise of irrigation. For application at times and places where irrigation would not be practicable, the antibiotics might possibly be mixed with commercial fertilizer, along with trace elements, or with seed-treating chemicals. They might even be sprayed or dusted, to be carried into the soil by rain.

Whatever the method and equipment of application, significantly higher crop yields might considerably alter the design requirements for soil-preparation, planting, pest-control, harvesting and handling equipment. The whole economy of agriculture might be changed considerably as to land classification, farm land values, economic sizes of production units and production equipment, relative importance of various crops, structural requirements, uses of electric power, grading of products, and processing to conserve possible new or added values in crops. Considering the rapid adoption of antibiotics to increase the efficiency of livestock production, it seems certain there will be early exploitation of whatever potential they may have for improving crop production. This use will add new and interesting possibilities to the considerations entering into agricultural engineering.

Index to Vol. 33

The title page and index to Vol. 33 of AGRICULTURAL ENGINEERING will be mailed with copies of the January, 1953, issue to ASAE members and other regular subscribers.

Eaton Parts Build Performance and Stamina into Modern Farm Machinery

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Through close cooperation with engine, vehicle, and implement manufacturers, Eaton research and engineering have been privileged to make many worthwhile contributions to the improvement of essential farm equipment.

Eaton engineers will welcome an opportunity to work with you in the application of Eaton valves, Zero-Lash hydraulic valve lifters, valve seat inserts, tappets, or other Eaton products, to engines and equipment.

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AGRICULTURAL ENGINEERING

VOL. 33 DECEMBER, 1952 NO. 12

New Horizons in Farm Machinery Development

By K. W. Anderson

MEMBER ASAE

EVERYONE in our United States has an interest in new farm machinery developments because our farm machines contribute so greatly to making ours the best fed and best clothed nation on earth. It is inevitable that the future will bring many new and exciting developments in farm machinery to maintain this standard. This will occur because our nation operates on the capitalistic system of competitive free enterprise—the system which more than any other requires engineers. In this system each manufacturer must continually improve his products and develop new ones in order to grow and maintain a profitable position. These facts are important; they should be repeated frequently, and they present the greatest challenge to engineers.

To achieve the continuously advancing goals of improved and new machines will require increasing man-hours of engineering. For example, 80,000 man-hours of engineering were required to develop a successful tractor in 1925; in 1950 the counterpart required 800,000 man-hours. This same trend applies also to other farm machines such as combines and balers. These facts are important for at least two reasons. First, new farm machinery developments do not *just happen*. They are the product of engineering effort that is sometimes staggeringly expensive. Second, the farm machinery industry's future requirements for engineers may be phenomenal.

When we think of new horizons in farm machinery development, it seems to me that we should first consider the problems of the user — the farmer. He starts with the soil. His problem is (1) to produce the food and fiber required for a growing population, (2) to make a reasonable profit, (3) to improve or maintain the productivity of the soil, and (4) to do the job with less and less labor.

"Resources for Freedom," the recent report of the President's Materials Policy Commission, sets forth the problem in this way: "The demand for farm products, including those required as raw materials by industry, is expected to rise steadily over the next 25 years. Within the Commission's basic assumptions, including a doubling of the gross national product by 1975, an increase of 40 per cent in the demand for all products of the land except timber seems reasonable. This 40 per cent figure is derived from estimates that a 1975 population of 193 million (28 per cent larger than that of 1950) will require production of 42 per cent more food, on a constant-value basis, and production of 25 per cent more non-foods." The same report suggests that "most of the desired 40 per cent increase in agricultural production can come from wider application of technology to increase crop and livestock yields per acre."

"Wider application of technology to increase crop and livestock yields" includes more applications of power, increased use of fertilizers, better seed, better pest control, conservation of water and the use of irrigation, improved drainage and better farming practices in general. These are all problems for the engineer.

Another problem for the engineer is the anticipated decrease in farm labor in the next quarter century which is also described by the report as follows: "An increase of 40 per cent in total agricultural production will call for a greater than 40 per cent increase in production per agricultural worker. Between 1939 and 1949 the number of persons employed in agriculture dropped nearly 10 per cent, to 10,756,000 in the latter year. In 1950 alone, 400,000 people left the farms. A further drop of at least 10 per cent in the next 25 years appears likely."

The current productivity of farms may provide a basis for appraising likely changes in the next twenty-five years.

In 1950, according to the U.S. Census, there were 5.4 million farms in the United States. The same census reveals that

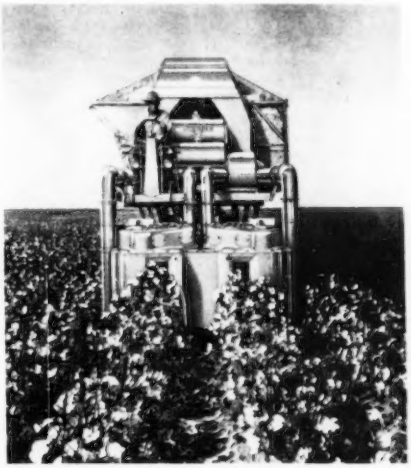
60 per cent of the farms produced 90 per cent of the value of products sold;
25 per cent of the farms produced 80 per cent of the value of products sold;
20 per cent of the farms produced 66⅔ per cent of the value of products sold;
10 per cent of the farms produced 50 per cent of the value of products sold.

This pinpoints the major problem of equipment needs to 3.3 million farms — the 60 per cent that produced 90 per cent of the value of product. For these farms, changes in the size of the various operations appear likely because of economic influences. In order for mechanization to be profitable, the optimum acreage for each type of farm must be achieved unless the farmer either has excess and unused capacity, or he must rely upon exchange of work or custom services. These alternatives are not attractive to farmers because farm operations are not flexible from a timing standpoint.

These general problems may provide a rough guide for the engineers who will be responsible for developing the needed equipment often referred to as the "machine tools of agriculture" in the next 25 years. In approaching them I want to suggest just a few ideas that engineers should consider:

1 Make an objective analysis of what farmers actually do; for example, apply industrial time-and-motion-study principles.

2 Appraise opinions obtained from visits to farms in terms of



This John Deere two-row, self propelled cotton picker is typical of the machines developed by agricultural engineers of the farm equipment industry to do what hand labor once did

An address before the meeting of the American Society of Agricultural Engineers held in conjunction with the Centennial of Engineering Convocation at Chicago, Ill., September, 1952.

The author, K. W. ANDERSON, manager, product research department, Deere and Company.

possible prejudices — yours or the farmers.

3. Use the recently developed specialized skills of opinion research, including their appropriate methods of scientific sampling and questioning.

4. Develop liason with every group knowing ways to solve farmers' problems such as experiment stations, agronomists, chemists, etc.

5. Use the reports of sales people as amber lights in detecting the weaknesses of your own machines and the effectiveness of competition.

6. Carry on more basic research.

7. Consider the conservation of all materials and natural resources as your obligation to future generations.

• • •

The remainder of this paper will deal with types of machines.

Please keep in mind that I do not pretend to be a prophet. I am projecting from the known into the unknown. Many unknowns of the next quarter century will change the direction of developments anticipated in the light of present conditions.

I. THE TRACTOR

The major characteristic of tractors is capacity which involves horsepower, speed and weight.

For a number of years there has been a trend to tractors with greater horsepower. As an illustration, in 1941 89 per cent of the tractors produced were under 30 bhp and 11 per cent were 30 bhp and over; in 1950 69 per cent were under 30 bhp, and 31 per cent were larger. There will be a continuation of this trend because the farmer can make the most productive use of his time by shifting from a two-plow to a three-plow tractor. Faster working speeds and higher crop yields will also increase the need for greater power.

Whether gas turbines or atomic power replaces piston engines in farm tractors during the next 25 years is a matter of conjecture. Since farm tractors will be in a low power range as compared to equipment such as aircraft, and because of the need for efficiency and economy, it appears that we will be using piston engines for quite a while. There has been a great deal of development in fuels, but it looks now as if we will continue to use gasoline, diesel fuel and LP gas. Volumetric efficiency will be improved, particularly when using gasoline with higher octane values. It also appears that engine speeds will increase. The diesel engine which is well known for its efficiency over a wide range of speeds can become more efficient with the use of fuel additives which improve the ignition qualities. At present small diesels are $800 to $600 more costly than gasoline engines of the same power. They can become less expensive in the future through design changes and by manufacturing economies that become possible through mass production. The extra rigidity and strength in the cylinder block, crankshaft and bearings, to withstand the higher compression pressures (16 to 1 for diesels as compared to about 6 or 7 to 1 for gasoline) will probably have to remain and give little basis for economies. There are economy possibilities, however, in the various accessories, including the starting means and the injection equipment — both pumps and nozzles. The gasoline engine will be potentially more costly as compression pressures are increased.

If there is a change in the basic configuration of present tractors, it may be in the direction of a compromise of the present low-center-of-gravity four-wheel general-purpose tractor and the tricycle tractor with slightly higher center of gravity and with greater implement and crop clearance. If, on the other hand, we have an entirely new approach, it will be because ways are found to accomplish many jobs better at reasonable cost, rather than simply to produce a strange innovation which caters to but a part of the total requirements. In the case of the large standard-tread wheel tractors that are used to pull large drawn machines and which compete with the lower size range of track-type tractors, we will eventually reach a traction limitation that may be answered by using drivewheels in tandem with transmission steering instead of the customary front wheels.

To improve adaptability, an infinitely variable speed transmission, comparable in function to that now used in almost all self-propelled combines, is in my opinion more valuable than a torque converter which has many limitations in the farm tractor.

Much progress has been made in the development of a common attaching means for integral implements as a part of the tractor, but more remains to be done. Some of these improvements include easier attachment, elimination of the interferences between tractor hitch parts and the various implement components, and better gaging properties, particularly when working in soils of varying density and over irregular terrain. As the integral implements increase in width, length and weight, the problems become more complex.

Improved operator safety, comfort, convenience in mounting, operating and dismounting are attainable in a greater measure than ever before, and the farmer will demand and be willing to pay a fair price for these improvements if — or as long as — economic conditions permit.

Tractor cabs will have a place even though their use introduces interference with many integral implements. In some areas the tractor cab may require air conditioning because of extreme heat and cold.

From the standpoint of convenience much progress will be made in improving the arrangement and operation of the controls which will continue to multiply in number because of the increasing functions the tractor will perform. Consider, for example, only three instances where hydraulic steering on the tractor would be particularly helpful: In the operation of a front-end loader, when making 180-degree turns at the end of

The machines in these two pictures are quite representative of the present stage of development of power-operated equipment to meet the demands of a rapidly expanding mechanized agriculture. (*Left*) This John Deere self-propelled combine symbolizes the modern trend, handles larger acreages with less man power, speeds the harvest, and reduces costs. (*Right*) This 20-ft John Deere "Surflex" tiller helps meet the demand of bigger acreages and for bigger machines, all aimed at the end result of more feed and food with less man labor.

the field with a four-row cultivator or similar implements, and when operating over loosely tilled land. With a hydraulic system built into the tractor, the application of power steering should not cost more than the customer is willing to pay.

We can assume that the farmer will not object to these innovations. As a matter of fact, he is expecting them. In the fall of 1945, I talked with a middle-aged "dirt" farmer who had just completed a hard day's work in the field with his tractor. In response to my general inquiry, he suggested power steering for the improvement of tractors. Remember this was a long time before car manufacturers offered this item as optional equipment.

2 SELF-PROPELLED EQUIPMENT

A self-propelled vehicle could be described or defined as any machine having its own source of power and means of propulsion. Actually a tractor with integral implements is one form of self-propelled vehicle. However, the self-propelled machines, as we have come to know them, are composed of a basic implement with a propulsion means. The inherent advantages of self-propelled machines — such as mobility in the field or for transport, saving of labor, crop-saving features, and convenience of operation — have firmly established this type of farm equipment. It promises to continue as single or multiple purpose.

Single-Purpose Type of Equipment. The self-propelled combine which harvests a multitude of grain and seed crops is the best known example of the single-purpose type. It will be continued and further developed so long as a substantial number of farmers have no other requirement for harvesting equipment. If designed for a single use, a machine requires a minimum of compromise with respect to performance and cost. A casual examination of today's self-propelled combine reveals that the engine and the propulsion means are definitely considered as accessories to the combine proper, an approach by which the engineer makes the best combine possible and selects and locates the so-called accessories so as to cause a minimum of interference.

Perhaps the greatest improvements of the future will be a reduction in the weight, size and cost of the power and propulsion units. One intriguing prospect is the use of a gas turbine in lieu of the conventional engine. From what we know of gas turbines, it would be possible to obtain a unit of sufficient power, including the necessary speed-reduction gearing, weighing only 25 per cent as much, and occupying less than half the space of the conventional piston engine. The big questions are original cost, cost of operation, and reliability for this type of service.

Multipurpose-Type of Equipment. The multipurpose machine is new and there is only one important commercial product now available in this category. It is a combine and/or a corn harvester. Other basic machines such as the automatic hay baler, forage harvester, cotton harvester and beet harvester may eventually be provided for use on a multipurpose, self-propelled chassis. Obviously an enormous amount of engineering work will be required to develop a single self-propelled chassis that will properly satisfy the important requirements of such a variety of machines as those cited. While this may take a good many years, the potential reward appears attractive.

3 TILLAGE EQUIPMENT

In approaching the problem of producing more food with less farm labor, all farm implements will be designed to make optimum use of improvements incorporated in the tractor. This means that tillage equipment will match the increased power in the tractor. Mere increases in sizes of such equipment as plows will not be the complete answer. The big job will be to accommodate greater speed. I am well aware of the many problems this raises and realize that some operating conditions will hinder the attainment of this end. For instance, in order to keep from pitching the soil too far, plow moldboards will have different shapes; striking obstructions at greater speeds will impose stresses on shares and other plow components in a measure that cannot be tolerated without adequate safety trip mechanisms, etc. In the case of the integral plows, which are sure to increase generally in preference over the drawn type, this problem may be solved by the use of individual trip standards that require little attention and can be easily relatched. Other tillage implements such as field cultivators will also be operated at higher speeds, and the teeth or standards will be improved or entirely redesigned to a new higher degree of adaptability. Some of the limiting factors on higher speeds with tillage machinery may be draft increases out of proportion to the work accomplished, inadequate riding comfort, or safety of the tractor operator.

Another important influence on tillage equipment in the next 25 years may be the demand for improvement in soil tilth to support higher yielding crops. For example, row crops may require special processing of the soil in narrow bands adjacent to the seed to assure close contact of the soil particles with the seed for better germination, emergence and early growth. Such an operation could permit leaving the soil between the rows in a coarser condition for better absorption and retention of the rainfall which in turn would reduce soil erosion.

It is entirely possible that proper soil tilth may be accomplished with less mechanical manipulation. Obviously there will be increased emphasis on current practices that affect soil tilth such as crop rotation, seeding of legumes, plowing under crop residues and green cover crops, and application of manure and other coarse materials. Closely related is the new approach of soil conditioners whose effectiveness is not yet generally proven nor whose costs will be known until mass-production techniques are thoroughly explored. With more favorable soil structure, the draft of tillage machines can be decreased, scouring problems can be reduced, and better granulation of the soil with present equipment will be possible.

4 PLANTING EQUIPMENT

For many crops it seems definitely established that there is an optimum number of plants per acre for maximum production on certain soils and with certain treatment. In an attempt to obtain the optimum stands per acre, equipment and planting methods are being improved. Placing the seed in the soil accurately as to depth and spacing may justify the expense of higher germinating and better graded seed. Improvements in cultivating methods, particularly by the use of chemicals, may permit drilling of crops in many areas where they must now be more slowly checkrowed to permit weed control.

Experience has proven that in a given area and with specific crops there is one so-called best time for planting. In the humid areas the soil is often suitable for preparation and planting for only short periods of time. Thus it is important to plant the crop quickly which accounts for the popularity of four-row planters and the capability of all planters to operate accurately at high speeds. Obviously the seed and fertilizer hoppers must have ample capacity.

With widespread interest in improved forage crops and pastures, it can be expected that much progress will be made in equipment for seeding these crops. Progress in pasture and range-land improvement during the past few years has indicated that with proper brush and tree-clearing equipment and techniques, and with the use of advanced planting and fertilizing methods, many millions of acres of waste land can be brought into production.

For many years there has been evidence that certain seeds may be treated before planting so as to facilitate accurate planting and early germination and growth. This treatment includes the coating of individual seeds to form pellets of uniform size or the placing of seeds, fertilizers, and insecticides in tapes which disintegrate after being placed in the soil. It is apparent that such practices, if expanded, will affect the design of planting equipment.

The inevitable increases in costs of improving planting equipment and methods can be justified in part by decreases in the thinning or replanting necessary to obtain satisfactory yields. Thousands of acres of cotton are now being successfully planted to a stand with delinted seed in areas where such a practice was formerly considered impossible. The high labor cost of thinning or chopping has forced this development.

5. CULTIVATING EQUIPMENT

It seems possible that more precise cultivation of some crops, particularly some of the truck crops, can be justified, and attempts in this direction can be seen in the use of power-driven soil working parts that operate close to the plants. One new machine of this type utilizes a photoelectric cell for automatic thinning of sugar beets and lettuce according to the size of product desired. It has been claimed that this implement may also be used for in-the-row cultivation regardless of the spacing of plants. This particular machine is mentioned merely to indicate the possibilities in precision farming which may be reached if and when the value of the operation can justify such precision. Cultivating for control of weeds and grasses has always been one of the greatest time and labor-consuming operations in the production of crops. In the corn belt, faster cultivating speeds made possible by use of flat sweeps and the rotary hoe attachment have permitted the operator to keep his crops clean of weeds and still have time to give to his small grain and hay crops which have often interfered with corn cultivation in the past.

Even though chemical control of weeds was employed on 30 million acres during each of the past two years, this process is still in its infancy. It has shown enough success to indicate great possibilities as the chemicals, the application equipment and the techniques improve. If we may judge from the developments during the past few years, these improvements can be expected reasonably soon. Chemicals will be better proven and equipment will be available for more accurate placement and dosage.

One of the most promising features of chemical weed control is the selective characteristics of various materials and the possibility of successfully controlling grasses and weeds in the crop row until the plants can compete successfully with them.

6. FERTILIZER EQUIPMENT

Closely related to equipment for tillage, planting and cultivation are the tools used for applying chemical fertilizers. American farmers used 18,666,000 short tons of fertilizer in 1951 — a 38 per cent increase as compared to 1950. According to the National Fertilizer Association, this was the thirteenth consecutive year in which the use of commercial fertilizer has increased. A substantial part of the 40 per cent required increase in food production during the next 25 years is expected to come from greater use of chemical fertilizers.

The problem facing the machinery industry is to anticipate the accelerating and ever-changing demand for fertilizer-application equipment. The fertilizing materials will undoubtedly be changed somewhat in physical properties. It is reasonable to assume that research by the chemical industry will lead to more uniform and more stable solid fertilizer materials. The use of anhydrous ammonia and of fertilizer solutions will probably require increasing quantities of specialized application equipment.

In fertilizing for maximum yields, uniform distribution becomes increasingly important. A slight overdose may produce an excessive chemical concentration in the plant root zone which will interfere with normal growth. Improved metering mechanisms and larger hoppers are two features which are certain to be emphasized in future fertilizer equipment development. Provision for easy and thorough cleaning of the application equipment is a must for satisfactory field service.

7. INSECT AND DISEASE CONTROL

Great advances have been made in the battle with the pests, but there seems at present nothing to indicate that it will ever be completely won. It is difficult to name a crop which is not attacked by some insect or disease which must be combatted. It may be a tree crop, vineyard, truck crop or field crop, they are all vulnerable. This means that continuous improvement in methods and equipment for economical control of insects and diseases is a must if agricultural production is to be kept at required levels.

From some of the work now being done, it seems quite possible that the use of electrically charged materials may assist in making controls more effective. Preliminary tests at Michigan State College have indicated that chemical dusts may be electrically charged to give a more effective coverage of plant foliage.

The application of liquid sprays for insect and disease control, even when effective, always has been a laborious and slow operation. The trend toward the use of large volumes of air at high velocities for applying chemicals to various crops permits effective application with low labor requirements. It seems safe to forecast that the near future will see further development of pesticides which may be applied at high concentrations with great covering capacity.

8. HARVESTING EQUIPMENT

Potential increased use of artificial drying with and without the introduction of heat appears to be one of the most important factors that can change harvesting practices. During the past 12 years there has been an almost complete switch from the binder-thresher method to the combine in harvesting of rice. This was made possible by the use of artificial drying which will have advantages for other crops as soon as it is economically feasible.

In the case of hay harvesting under unfavorable climatic conditions, there are alternate methods of dealing with the curing problem without the use of artificial drying. As an example, hay can be processed with a forage harvester and blown into a silo when the moisture content is at the maximum of about 80 per cent. An interesting new development is the hay crusher which is used at the time of mowing to split the stems and substantially reduce the normal curing period. Artificial drying of hay seems to be an adjunct to natural curing whereby the moisture is reduced from a range of 25 to 35 per cent down to approximately 20 per cent. Where such a practice is employed, the design of hay machinery should include provision for a longer cut for the forage harvester and means to produce less dense but durable bales from the automatic baler.

Harvesting small grains, other than rice, has recently made experimental use of artificial driers on combine harvesters. The exponents of such equipment claim elimination of windrowing and increased daily output because of being able to operate when the grain is damp. How far artificial drying will expand is dependent upon its economic advantages. It should be kept in mind that the cost per acre for windrowing grain is low and the daily capacity with a large machine is over one hundred acres.

Artificial drying of corn introduces some interesting potentials. In the principal corn-growing areas, harvesting normally occurs during a period of the year when drying conditions are often adverse, and the crop may be soft or immature. This condition persists in spite of the use of early maturing hybrids. Early harvesting with artificial drying can reduce both ear and shelled corn losses. While artificial drying can be and is being applied to ear corn, the benefits from treating shelled corn appear to be even greater. By using artificial drying it is possible to combine the picking and shelling into one operation to a far greater degree. Use of this latter method saves labor, leaves the cobs in the field, and reduces the amount and cost of storage capacity required. Because of the importance of the corn crop — which ranks first in harvested acreage — it can be expected that there will be major developments in corn-harvesting equipment. Perhaps the current combination picker-sheller may be only the forerunner of what is to come.

For years artificial drying has been used in the curing of tobacco and sweet potatoes. The use of this drying process, together with windrowing, has made possible field harvesting of peanuts by the combine method. Experience with combines in handling peanuts is gaining momentum and further improvements appear likely.

The search for all sorts of new harvesting machines will continue because of the need for replacing hand labor that is costly, difficult to procure and frequently unreliable. I believe that the labor situation can become sufficiently critical over the next 25 years to make certain crops, requiring a great deal of hand labor, to decline in popularity because their selling price in competition with other crops will become prohibitive. Since World War II there has been a number of successful efforts in mechanizing the harvesting of such crops as cotton, sugar

beets, potatoes, castor beans and sweet corn. There is every reason to believe that these new harvesting machines will be improved for better field performance, greater durability and possibly lower cost.

The standard hay-making machines, power mowers, side-delivery rakes, automatic balers, forage harvesters and combination loader-stackers are, and will continue to be, important items of equipment on the farm because hay is the second largest crop in terms of acres harvested. New power mowers will have increased cutting capacity, probably through the use of a longer cutter bar and/or by faster knife speed made possible through the use of a better balanced driving mechanism. Side-delivery rakes with the new right-angle reel which handles the hay more gently and permits raking speeds up to 7 mph will predominate, particularly if a lower cost version becomes a reality. There will be a great deal of activity in automatic baler development with emphasis on low-cost machines having good capacity. During the next 25 years the forage harvester will be improved and will attain increased acceptance because of its versatility. There will be some noteworthy advancements in the handling of this chopped material, both from the forage wagon and into storage. A new design of elevator which can be satisfactorily operated with less power (possibly a 5-hp electric motor) and which handles the crop more gently, may replace the blower when these considerations are important. The combination loader-stacker when mounted on a tractor meets with particular favor where it is a common practice to stack in the open. Improvements in this machine will be increased durability and easier methods of attachment and control.

9 MISCELLANEOUS EQUIPMENT

The farm has long been famous as a place where many jobs were done by hand. Some were of the "rainy day" type; others of the time-consuming variety that must be done frequently if not actually every day. These jobs, more than the field work, were responsible for the long working day common on the farm until recent years.

Let us enumerate some of these jobs and some of the equipment that is being made available to lighten them. The soil-handling chores, including filling in around farm buildings; road, ditch and terrace repairs; and construction of farm ponds, are facilitated by the use of tractor-mounted scoops, blades and ditchers. Fencing is less burdensome, thanks to the tractor-operated posthole digger. Snow shoveling is passe with tractor snowplows. The handling of materials such as fertilizers, hay, seed, grain or manure can be accomplished with a tractor-mounted loader, hoist, stacker, crane or fork lift. Elevators, conveyors, blowers and spreaders are also included in the equipment list.

Providing water at almost every point of usage, including the farm home, can be a reality with modern electrically operated pumps. Chopping ice in the stock tank has passed in favor of the electric heater. Milking the dairy cows and storing the milk is facilitated by use of modern milking machines and electric refrigeration.

Many existing items of miscellaneous equipment have not been mentioned because of lack of time, but even so there are a number of burdensome chores yet to be mechanized. We can expect improvements in present machines such as more trouble-free operation and lower cost both of which will encourage more widespread usage.

10 NEW MATERIALS AND PROCESSES

The farm industry uses steel and cast iron as the major items in the manufacture of implements. These will continue to be the major materials, but some inroads by aluminum and plastics will be made in places where the corrosion resistance and weight of aluminum are advantageous and the weight saving and wearing characteristics of the plastics are important advantages. Both plastics and aluminum are costly today and increased use will be helped by lower cost. The expansion in both of these fields in recent years should enhance the possibility of using these materials in markets now foreign to them.

Steel as a major item will probably continue to hold its place. However, in such items as gearing, shafting, and bearings, the alloy steels now used will probably change. The alloys now used in steel will undoubtedly be replaced to a large extent by those having minute amounts of boron, which imparts an equivalent ability for hardening. The use of some of the rare elements and light metals to improve the toughness of steel and the structure of cast iron will undoubtedly grow. Induction hardening, selectively hardening the outside of steel by high-frequency electricity, will allow a superior product to be made in many cases. This is in use now and it is believed its application will broaden. The hardening of steel by carburizing will in many cases be replaced by carbonitriding, in which process ammonia is added as well as a carbonrich gas. This imparts an exceptionally hard surface and the parts are relatively free from distortion. The use of this process will increase.

Greater attention will be paid to obtaining higher dimensional accuracy and finish on gray iron and malleable castings. The process of making castings in resin-bonded sand instead of the clay-bonded sands now used will find a place because of the improved accuracy and appearance. A wider use of high-strength malleable iron will probably come because of the advantage in saving weight and improving wear resistance. Arc welding of steel members will in many cases be replaced by resistance welding. Improvement in strength and cleanness of design is possible with this method.

Much progress has been made over the past ten years in materials used in finishing or painting implements. There is need for continued improvement and this will undoubtedly come about.

The major emphasis for the next 25 years will be on utilizing materials at a saving in initial cost to the manufacturer but with an improvement to the user through increased attention to manufacturing processes and control. This will enable the farmer to purchase an improved-quality product which will use less of our scarce materials through the ingenuity of the design and process engineer.

GENERAL

One of the over-all general improvements in all farm equipment will be a reduction of down time. I have repeatedly stressed the need for increased capacity because of the shortage of labor, the importance of timeliness for completing many operations and the matter of handling higher yielding crops. One of the contributions that can be made to this end is less frequent lubrication. We have some favorable experience with prelubricated precision anti-friction bearings but are just beginning to procure a bearing of this general type — except that it is non-precision and far less costly. This latter bearing is well suited for many jobs, particularly if it is readily accessible for replacement. In some instances, it will be of a higher quality than the bearing which it replaces. Even with a minimum service life, such a bearing can be an excellent selection. Expanded use of rubber bushings to suspend oscillating components as found in a harvesting machine can be expected as this frequently results in better service life in addition to elimination of lubrication. Obviously such functional improvements which further reduce stoppage from clogging in difficult conditions (which can predominate more with higher yielding crops) will be a highly important factor in reducing down time.

Many of the new farm machines will reflect the contribution of the industrial designer. This small but effective group has proven its ability to assist engineers in developing products that have better appearance, greater utility, and a host of other advantages. I am sure this cooperative work will continue at an accelerated rate.

CONCLUSION

In the next 25 years we can expect a substantial increase in population with a correspondingly greater requirement for food and fiber. The labor force on the farm will continue its steady decline. Engineers will develop new and improved machines to enable the American farmer to meet these production goals. Everyone participating in this over-all effort will enjoy a higher standard of living in proportion to his contribution. This will be the product of the activities of the people who thoroughly believe and practice the American system of free enterprise.

Current Research and Developments in Farm Structures

By Wallace Ashby
LIFE MEMBER ASAE

AGRICULTURAL engineering research, teaching and extension are helping to start a revolution in farm buildings. In the next 10 or 20 years there should be more progress than in the past 50 or 100 years, as farmers recognize the possibilities of buildings for increasing production and cutting costs. Other causes of this revolution are the mechanization of field crops, scarcity and cost of farm labor, rural electrification, new types of building equipment, and need for better quality and sanitation of farm products and reduction of storage losses.

There are now on farms more than 5 million farmhouses and perhaps 25 million other buildings. The investment in these buildings is more than $20 billion. Farmers are constructing nearly a million new buildings per year. In 1949 their expenditures for new buildings, improvements and repairs were nearly $2 billion (1)*.

The farmhouse is the most important farm building because it is at once the home, the farm headquarters, and an important work center.

The barns, poultry houses and other livestock shelters are factories where grains and forages are transformed into meat, milk, eggs, and the like. Farmers have spent much of their working time in these buildings because livestock chores have been slow, dirty work. Now that the chores are being mechanized, building designs are changing.

Storage buildings are necessary to keep seed, feed, and some cash crops from harvest until use or sale, which often involves grading, washing, and packaging. New methods of handling and crop conditioning in the buildings save time, recover a larger percentage of the yield, and have other advantages. New types of storages will take full advantage of these developments.

Some people may think that farm buildings are important only to farmers, but the consumer has just as definite an interest, because these structures affect the availability, quality and cost of his food. The reason health officials inspect dairy barns, for example, is to assure a clean milk supply. If we in this country, with our increasing population and only limited amounts of new land available, are to maintain our standard of living, the present farms must increase their production. One way to do this is through farm buildings that will improve farming methods, increase the percentage of crop-yield harvested, reduce losses of stored products, and improve the efficiency of converting feeds into livestock products.

OBJECTIVES AND ORGANIZATION OF FARM BUILDING RESEARCH

Stating it another way, the objectives of farm building research are to *(a)* increase production, decrease crop and animal losses, improve quality and decrease labor hours and costs of farm products; *(b)* develop better ways of storing food reserves; *(c)* reduce building costs; *(d)* promote a higher standard of farm living.

Organized research in this field is carried on by the U.S. Department of Agriculture, the state agricultural experiment stations, and the manufacturers of building materials, prefabricated buildings, and building equipment. In USDA, engineering studies of farm buildings are carried on by the Bureau of Plant Industry, Soils, and Agricultural Engineering, economic studies by the Bureau of Agricultural Economics, and studies of the functional aspects of farm housing by the Bureau of Human Nutrition and Home Economics. Other USDA agencies cooperate in some phases of these studies. At the state agricultural experiment stations, the departments of agricultural engineering, agricultural economics, and home economics are most active. Almost all research conducted by agricultural engineers involves cooperation with scientists of other training. Much of this research involves cooperation with practical farmers.

Industry cooperation is largely through the state agricultural experiment stations and colleges. It often takes the form of research graduate fellowships for study of problems involving a specific material—wood, steel, plywood, aluminum, clay products, glass, etc. In other cases, buildings or equipment are furnished to the experiment stations to assist in carrying out broad studies, involving state and federal research workers. For example, comparison of the loose-housing and stanchion-barn methods of housing dairy cattle, or the measurement of grain pressures in buildings.

TYPES OF FARM BUILDING RESEARCH

Let me emphasize the organizational setup of USDA research in this field. No farm problem is encompassed by one agency. Bringing together the interested scientists, enlisting the help of industry and of several states where there is a regional problem, setting up the project at a state agricultural experiment station, and trying out the new ideas with interested farmers, all makes for a strong team. It is a good way and also a necessary way, for Congress expects that most of the research funds be spent away from Washington. It has some drawbacks. When foreign visitors, who come in increasing numbers, are in Beltsville, we have little to show them of our actual operations, and sometimes it seems that all our engineers are away from the office on field work.

Current engineering research recognizes many problems. The USDA and the state agricultural colleges receive from farmers thousands of requests each year for plans of the most efficient types of buildings and for information on heating, ventilation, water supply and waste disposal, feeding, watering, and other equipment, details of construction, and many other subjects.

There are a dozen or more types of livestock enterprises and an even larger number of crops that require storage, each with some distinctive housing requirement. These requirements are modified by variations in climate, availability of building materials, and market demands. It will be possible in this report to describe only a few projects that illustrate the most active fields of study.

RESEARCH IN FARM HOUSING

You will not be surprised to hear that farm housing is still below the standard of either urban or rural non-farm areas (2). The 1950 Census shows that the percentage of old and dilapidated houses on farms was larger than in either urban or rural non-farm areas, and that farmhouses were particularly lacking in modern conveniences. For example, 55 per cent of farmhouses did not have running water as compared to 2 per cent of urban and 28 per cent of rural non-farm houses; 83 per cent did not have central heat, as compared to 38 per cent without central heat in urban areas. Only 24 per cent of farmhouses had flush toilet, bath, and hot running water, while 78 per cent of urban houses and 48 per cent of rural non-farm houses had these conveniences. Yet capable farm families expect a higher standard of living, including better housing. It is also important that qualified tenants and laborers have good housing so that they will not leave the farm.

As a basis for a broad program of farmhouse improvement research, the state agricultural experiment stations, with the cooperation of USDA, have made surveys to determine present patterns of farmhousing and household activities, and typical inventories of household possessions, equipment and supplies in the four main geographical regions of the United States. The surveys also determined the preferences of farm people

An address before the meeting of the American Society of Agricultural Engineers held in connection with the Centennial of Engineering Convocation at Chicago, Ill., September, 1952.

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*Numbers in parentheses refer to the appended references.

for types of houses, preferred locations for doing household tasks, and storage of possessions and supplies, equipment needs, and the like. The survey findings are reported in four regional publications (5).

The results of these studies form the basis for research projects dealing with equipment, room arrangement, and overall design. Much effort is devoted to means of lowering cost. Dual use of space is a possible answer to one phase of the problem.

In the USDA, we are developing a series of plans for small expansible houses, in the first stage of which the kitchen, living room, and bath form a complete living unit similar in concept to but larger than the city "efficiency apartment." Dining space and laundry facilities are provided in the kitchen and a curtained sleeping space in the living room. When completed the houses will have two or three bedrooms. A group of these units, differing in arrangement and selection of materials, is being constructed at the Agricultural Research Center at Beltsville, Md.

Several unconventional types of construction are being tried that appear to have possibilities of economy, including *(a)* a reinforced concrete grade beam resting on concrete posts that go below frost in place of a full-depth foundation; *(b)* elimination of sheathing and application of sheets of ¼-inch cement asbestos board directly to face of studs spaced 24 inches on centers; *(c)* use of frameless windows; *(d)* use of sheathing spaced two feet on centers instead of tight sheathing. Records are being kept of the time and material required to construct the various parts of each house, whether experimental or conventional, and of erection procedures and ease of erection of various parts of the houses in order to arrive at a basis for comparison. Studies of comfort, convenience and adequacy of the houses for family living will be made by home economists.

Sometimes we are asked why special farmhouse plans are needed. The answer is that a farmhouse works differently from a city house, and a farm family cannot very well move into another house if the one it has does not meet its needs. As already pointed out, the farmhouse is part of the farm production plant. It is the headquarters or office of the farm business as well as a home. It has a functional relation to the other farm buildings which are a part of its business. The kitchen is the watchtower of the farmstead. Most meals are eaten there, and it is the workroom for the processing of farm products for sale as well as for home use. Since there is traffic between the house and the farmstead all day long, the house must be planned to accommodate this traffic without its passing through the kitchen work areas. All parts of the house should likewise be accessible from the principal entrance without passing through other rooms. Good housekeeping is made possible by careful planning of these features. Finally, the farmhouse plan must more nearly provide for all the requirements of the farm family, which in an urban location would be partially satisfied outside the home.

RESEARCH IN LIVESTOCK HOUSING

Structures of some sort are needed for production of all types of livestock. For cattle and sheep on the southwestern ranges, only fences, gates, and corrals to control the animals may be needed. In the colder climates buildings must also provide protection from weather and convenient and sanitary arrangements and equipment for caring for the animals. Dairy cattle, swine, and poultry require better equipped and more costly buildings than other types of livestock.

LABORATORY RESEARCH IN HOUSING REQUIREMENTS

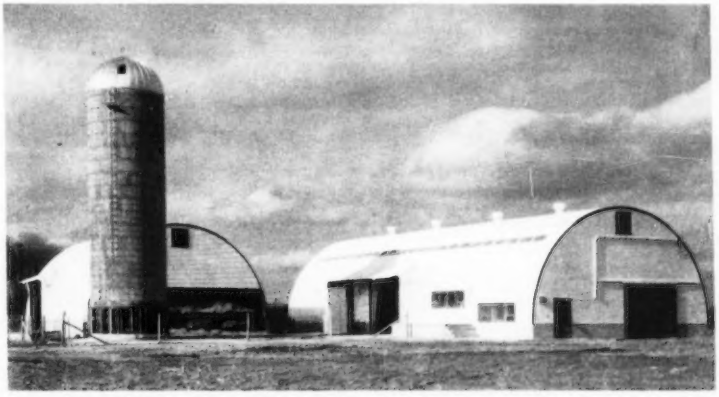
Dairy Cattle. Since dairy products rank high both in farm value and in labor requirements ($4.6 billion and 3.0 billion man-hours in 1949), buildings for housing dairy cattle are under particularly intensive study.

The USDA and the University of Missouri cooperate in research at the psychroenergetic or climatic laboratory built in 1946 at Columbia, Mo. This laboratory consists of two stables, each accommodating six cows, with necessary air conditioning and other equipment. Temperature, relative humidity, air movement, and artificial light can be controlled independently within wide limits. Space per animal can be varied by changing the number of animals in the stables. Two of the objectives are: to determine the environmental conditions under which cows and young animals utilize feed and cows produce milk most efficiently, and to obtain basic data for designing barn-ventilation systems and structural features for temperature control. In addition, the project is providing opportunities for physiologists to obtain a large amount of valuable information on animal reactions under various environments. Studies of temperature and relative-humidity effects have been completed, analyzed, and reported in a series of publications of the University of Missouri (4).

The optimum milk production of Holstein and Jersey cows in stall barns appears to be at temperatures of about 50 F. The effects of high temperatures upon milk production were much more serious than those of low temperatures, particularly with large cows. These laboratory results help to explain why summer milk production per cow in the South is below that in the northern dairy regions and indicate the importance of protecting cows from high atmospheric temperatures and humidities.

The total heat given off per 1,000 lb cow was nearly 4,000 Btu per hr at 10 F, but only about 2,000 Btu per hr at 100 F. The latent heat equivalent of the moisture removed from the chamber by ventilation, including both moisture from the cows' bodies and evaporation from gutters and other building surfaces, varied from about 10 per cent of the total heat at 10 F to practically 100 per cent of the total at 100 F (5).

Poultry. At the Agricultural Research Center at Beltsville, Md., a study is being made of the effect of environment on chickens. The two calorimeters used in this study each accommodate ten laying hens or 400 baby chicks. Temperatures can be varied from below 0 F to above 100 F, and relative humidity, air movement and light are controlled. To date, preliminary tests have been made at temperatures from 36 to 88 F, and with relative humidities between 60 and 70 per cent. The total heat productions in Btu's per hour per 5-lb hen were as follows: At 40 F room temperature, 53 Btu; at 57 F, 49 Btu, and at 85 F, 34 Btu. Egg production was slightly higher at 55 to 60 F than at 38 to 42 F, and 50 per cent higher than at



New types of dairy buildings at Michigan State College. Loose-housing barn, with milking room and milk house at right; hay drying, storage and feeding barn at left rear; self-feeding silo in left foreground

85 F. The hens ate more feed, drank more water and voided more liquid in the litter at low than at medium or high temperatures. This helps to explain the "wet litter" problem so common in poultry houses (6).

Swine. Studies of the effects of temperatures on growth of swine are in progress in the psychrometric chamber of the University of California at Davis, Calif. In these tests the rate of gain was greatest and the amount of food to produce 100 lb of gain was least at an average temperature of about 75 F for hogs weighing 70 to 144 lb, and at about 60 F for hogs weighing 166 to 260 lb. As the air temperature was raised or lowered from these averages, rate of gain declined and utilization of feed was less efficient (7). These studies provide a valuable guide for hog house design.

One of these tests showed the value of evaporative cooling in maintaining comfortable conditions for animals that do not sweat. Two-hundred-and-fifty-pound hogs on a dry floor were seriously distressed when air temperatures were 100 F, even with low relative humidity. When a trickle of water was run over the floor, the hogs lay in it, then turned over to expose their wet sides. On the wet floor the air temperature could be raised to 115 F without seriously distressing the animals.

The heat loss from hogs of 58 to 81 lb weight was about 475 Btu per hr at 40 F, 380 Btu per hr at 70 F, and 425 Btu at 100 F. For hogs of 275 to 381 lb weight the corresponding figures were 1,200, 825, and 800 Btu per hr. Sows with litters of four to eight pigs gave off about 1,600 Btu per hr at time of farrowing and 2,500 to 3,000 Btu per hr when the pigs were eight weeks old.

Water removed from the chamber in the ventilating air, including evaporation from the chamber surfaces, was 0.4 lb per hr at 40 F and 0.5 lb per hr at 100 F for the small hogs. The corresponding figures for the large hogs were 0.35 and 0.90 lb per hr. For the sows with litters at temperatures of 60 to 80 F the water removed was 0.8 to 0.9 lb per hr at farrowing and 1.0 to 1.5 lb per hr when the pigs were eight weeks old (8).

FIELD STUDIES OF LIVESTOCK HOUSING

The laboratory studies are providing a foundation for other work in livestock shelters. For the first time we have definite information on the temperature and humidity under which dairy cows, hogs and poultry produce best and the penalties that are incurred if other than optimum conditions are provided. However, much work is needed on ways to provide optimum conditions at reasonable cost. Several experiment stations and manufacturers of aluminum products are studying means to protect livestock from solar radiation and thus increase production. As an example, the California Agricultural Experiment Station and USDA are studying how to protect beef cattle in the Imperial Valley from excessive summer heat which causes them to lose appetite and interferes with weight gains.

Careful measurements of radiation from the sun, the sky, the ground, and other surfaces, and of heat transfer to and from the animals show that the greater part of the solar heat can be intercepted by shades, but it is much more difficult to cut off reflected radiation from the ground (9). Theoretically, the animals should be shaded from solar heat while radiating heat to the cool sky, but no practical way has yet been found to accomplish this. While the use of shades adds considerably to livestock comfort, in summer it is not enough to accomplish most economical production and use of feed. Tests are therefore being made of other means of cooling, such as evaporative cooling of cheap enclosed shelters, sprays directed on the animal, and cooled drinking water.

Research to Improve Stall Barns. A serious fault of most old dairy barns is that stalls are not large enough; cows are too close together and lie partly in the gutter where they get dirty and suffer injuries to udder and legs. A study at the West Virginia Agricultural Experiment Station, in cooperation with a manufacturer of barn equipment, found that allowing the cows adequate space and freedom markedly reduced injuries and increased milk production. Similar results have been found by other investigators.

At Iowa State College, a heat exchanger to improve ventilation in winter has been developed. It uses the outgoing air to warm fresh air entering the stable, thus reducing heat losses due to ventilation. The tests show that up to 70 per cent of the heat that would otherwise be lost in the exhaust air can be regained, thus making it possible to maintain desired stable temperatures even in poorly insulated buildings (10).

A large glass manufacturer is cooperating with state agricultural experiment stations and others in applying solar-heating principles to the dairy barn and other farm buildings to make use of the sun's heat in winter and shade it out in summer. This principle has been found useful in reducing excessive humidity in dairy barns and hog houses, providing desirable warmth for the milkhouse, and keeping poultry-house litter dry.

Loose Housing for Dairy Cows. Agricultural engineers cooperating with dairy specialists, sanitarians, economists and farmers have performed valuable service in perfecting the "loose-housing system" of handling dairy cows. The cows run loose in pasture, yard, or open shed, except at milking time, and are milked in a clean, well-equipped milking room with stalls for only a few cows at a time. The system has been used for years in warm climates but has only recently been adapted to cold climates, as it was thought that the animals would suffer if not kept in a warm stable. Studies made by the Wisconsin Agricultural Experiment Station with the assistance of a large steel manufacturer and confirmed by other stations and farmers show that under this system the cows grow a warm coat of hair and produce milk in about the same amounts as in warm barns. They are protected from rain and snow by open sheds and the manure and bedding are allowed to accumulate in the resting area to form a thick pack in which some fermentation takes place, thus providing a warm, soft bed. This pack of well-preserved manure is removed in spring using a tractor-operated manure loader. However, the feeding area should be paved and cleaned frequently. When the system is well planned and managed, the cows keep as clean as in stanchion barns and are freer from injuries (11).

Agricultural engineers, dairymen, sanitarians, and industry have cooperated in improving the milking room. In the new types, 25 or more cows per hour can be milked by one man. With the cows standing on a platform 30 in above the operator's floor level and the use of pipe-line milkers, the operator need do little stooping, lifting, or carrying. With this system the labor of milking is so reduced that there are numerous cases of farmers, who formerly kept 10 or 12 cows, expanding their herds to 25 or 30.

Stanley A. Witzel, University of Wisconsin, has this to say about dairy housing research with particular reference to the loose-housing system:

> If milk is not to become a luxury, the time has come when new ways of producing milk more efficiently and at lower cost must be promptly and widely adopted. Research within the North Central Region is ready to "sugar off" almost any time. Young, alert dairy farmers, many with a fast-growing record of successes, have taken over the findings of research on dairy-cattle housing within the region and put them to work. It would seem that the stage is set for one of the quickest, far-reaching shifts in an agricultural practice this nation has ever witnessed."

Infrared Brooding of Pigs. Chilling at birth is thought to be an important cause of death of some 40 million pigs per year. Since the mother sows do not produce body heat enough to maintain safe temperatures in the farrowing quarters in cold weather unless the building is well insulated, many farmers use stoves or "pig brooders." Studies now in progress by the Purdue Agricultural Experiment Station, USDA, and industry indicate that radiation from infrared lamps is a more effective means of warming baby pigs than earlier methods (12). Adoption of this practice will no doubt result in modification of farrowing-house design.

Saving Time and Labor in Livestock Buildings. With nearly 5 billion man-hours per year spent on farms in the care of milk cows, hogs, and poultry, it is obvious that research is needed to improve building layouts, equipment, and work methods to save all possible labor. Several such studies are under way.

For example, one on dairy buildings in Illinois is finding the time and travel required for feeding, milking, barn cleaning, etc., under different barn arrangements and using different equipment and methods. In some cases buildings have been remodeled after the first records were taken, then restudied. By careful planning it has been feasible to cut the man-hours per cow to half of the original, or less (18).

Another project at the Illinois station is developing push-button equipment for automatically conveying ear corn or small grains from storage to a feed grinder, mixing the ground feed and conveying it to the feed bunks with very little human attention.

Industry has contributed many devices for saving labor in livestock buildings. Hay and litter carriers, bucket-type milking machines, and automatic water cups have a long record of labor saving. Newer types of equipment, such as pipe-line milkers, gutter cleaners, cow trainers, and silo unloaders save more time and energy and contribute toward better products.

Changes in methods of feeding and handling cattle, sheep, swine and poultry have made it necessary to design new types of structures and equipment, with labor and feed saving in mind. For example, the use of automatic feeding trucks in beef-feeding yards has made it necessary to redesign mangers, cattle platforms, and shelters for protecting the feed.

RESEARCH IN GRAIN AND SEED STORAGE

The value of grains stored on farms annually is about $8 billion. They are among our most important human foods. Livestock convert them into meat, milk and eggs, while industry converts them into bread, alcohol, starch, and other products. Farm-stored grains are important reserves in case of drought, flood or war. Research has shown that grains and seeds can be stored for years at low cost and with little deterioration, but actual practice is quite a different story. It is estimated that between 5 and 10 per cent of all grain harvested annually is destroyed by rats, mice, insects and molds, most of this damage occurring in farm storage. These losses would soon pay for better buildings. Also, the Food and Drug Administration is insisting that grain contaminated by insects or rodents must not be processed for human food.

The grain storages on most farms were built, or at least they are like those built, when grain was cut with a binder and threshed after drying in the field. Grain was then usually dry enough to store safely in any building that would keep out rain, snow, ground water and rodents, and that could be fumigated for insect control. Similarly, most corn cribs provided only ventilation enough to dry corn that was already half dry when harvested in October or November.

We know that the ripening grain of wheat or kernel of corn has all the food value it will ever get when it still holds about three times the moisture with which it can be safely stored. High-moisture grain can be harvested with the ordinary machines, but this has not been done in the past because grain could not be stored safely until it had dried on the stalk. Now research has developed and is perfecting methods of mechanically drying grain cheaply and efficiently. This means that crops can be harvested two to four weeks earlier, thus minimizing risk of bad harvest weather or storm damage. Winter wheat following corn may be sown earlier to yield a heavier crop and by selection or perhaps with development of suitable varieties it may be practical to harvest crops of corn, winter wheat and soybeans from the same land in a two-year instead of a three-year rotation.

Seed of high germination is exceedingly important to production of good crops. Hybrid-corn growers have pioneered in drying and storing seed corn to maintain high quality. There is equal need for buildings and equipment that will maintain high germination of other grain, legume and grass seeds. This is especially true in the southeastern states where many new soil-improving and pasture crops are being introduced and where high atmospheric temperatures and humidity cause rapid loss of germination with ordinary methods of storage.

While much of the research on grain and seed storage by both industry and public agencies has dealt with drying methods and equipment, which will be discussed by H. J. Barre on the rural electric program at this meeting, research is also concerned with developing the new types of buildings needed to meet modern demands. Adequate structural strength and economy are primary requirements. To provide more complete design data, the measurement of grain pressures on vertical, horizontal and sloping or irregular surfaces is under way by USDA and the Iowa Agricultural Experiment Station, in cooperation with a manufacturer of prefabricated metal buildings. If drying is to be done in the storage, provision must be made for ducts or other means to distribute the drying air. Manufacturers of prefabricated buildings are cooperating with state agricultural experiment stations and USDA in developing and testing buildings in which grain can be dried and stored cheaply and efficiently.

Other research has shown that during long-time storage there is a tendency for moisture in normally dry grain to concentrate in certain portions of the mass and cause deterioration. This can be controlled by slow ventilation of the grain. Industry is cooperating with the public research agencies in developing and testing ways in which this can be done at low cost (14). New types of portable equipment for moving grain quickly and cheaply are likewise being developed.

BUILDINGS FOR STORING HAY AND FORAGE

Increasing use of the pickup baler and the field forage chopper are bringing major changes in buildings for storing hay and forage. These crops total some 100 million tons per year, almost all stored on farms, and with a value of more than $2 billion. The small bulk per ton of baled or chopped hay favors the use of 1-story or low 2-story buildings rather than the deep mows used for loose hay. Since there is less air movement through baled or chopped than through loose hay, it dries more slowly and in the humid sections mow drying is often needed. Research on this subject is developing efficient methods of drying hay that are readily adapted to ordinary barn mows (15). Industry has developed special hay storage buildings with built-in ventilation systems for forced-air cooling of the forage after it is put into the building.

Research now in progress at the New Jersey Agricultural Experiment Station and other experiment stations is developing buildings and methods for the "self-feeding" of chopped hay, other forage and silage, which greatly reduce the labor of handling the material. Corn silage is being self fed successfully from tower silos, but grass silage is still a problem. A new development is the self-feeding of cattle from trench silos.

Industry has developed, among others, an airtight steel silo, a plywood silo eliminating the customary steel hoops, and several types of mechanical silo unloaders which save much time and effort in handling this material.

FRUIT AND VEGETABLE STORAGE

Because of high moisture content and susceptibility to injury, the storage requirements for fresh fruits and vegetables are much more exacting than for grain, seeds, or forages. Maintenance of high quality requires temperature and humidity control with uniform conditions throughout the storage. This control, plus the great weight of the stored product and the need to avoid damage in handling, add up to a series of complicated problems.

New mechanical-handling methods are calling for buildings with large rooms, high ceiling, and a minimum of posts, so that highway trucks, fork-lift trucks or long conveyors can move freely inside the building. For example, in some of the newer buildings, apples are being moved into storage and stacked 18 to 20 ft high by fork-lift trucks handling pallet loads of 36 to 48 boxes.

In other cases, mechanically harvested potatoes are moved into bins by long conveyors that can be adjusted to roll the tubers onto the storage pile to avoid bruising, or, at worst, drop them only a few inches. At the end of the storage season, the potatoes may be rolled into a sluice of flowing water and floated to the grader. Another method is for the digger to lower the potatoes into large boxes. The boxes are hauled to the storage on highway trucks and handled in the house with fork-lift trucks. Potatoes remain in the boxes until graded for market.

Storage of fruit and vegetables in large boxes or pallet stacks changes the rate of cooling of the product and requires corresponding changes in ventilation and air-circulation systems. Study of all these problems is under way by state agencies, USDA, and industry (16).

BUILDINGS FOR TOBACCO

Tobacco and sweet potatoes are examples of crops that must be cured before storage. Particularly with tobacco, the market quality and value depend largely on control of the curing process, which is done in "tobacco barns." Current research by state experiment stations, USDA, and industry deals with analysis of the effects of environmental conditions on chemical and physical changes in the product during curing. Development or adaptation of heating and ventilating equipment and controls, and design of buildings to meet environmental needs and to reduce labor requirements for handling the crop into and out of storage are important, as tonnages are large and the products must be handled carefully to avoid damage to quality.

RESEARCH ON MATERIALS AND BUILDING METHODS

A study of suitability and durability of common materials used in farm buildings is being completed in the 12 north central states. Engineers visited 1,346 farms and got records on types of materials used in 2,839 buildings. The study covered application, exposure and age of the material and related data, condition at time of observation, and reasons for deterioration or failure, if any. Results now being analyzed will be of value both in selection of materials for various uses and in pointing out how they should be applied for best results.

As the result of research, development, and adaptation by many agencies, the use of concrete for building floors, livestock feeding floors and walks has done much to lift farmers out of the mud and lighten their work. However, there is need for a low cost, readily available building material similar to ordinary concrete but with better insulating properties. A number of studies have been or are under way in which concrete with admixtures such as sawdust, farm wastes, asphalt, soil, or air-entraining agents are being tested.

Much of the research on materials for farm construction is done cooperatively by industry, state agricultural experiment stations, and USDA. For example, glued, laminated-wood arch rafters developed by the Forest Products Laboratory and the lumber industry have found wide farm acceptance, at least partly as the result of tests by the state agricultural experiment stations. Large bowstring trusses, laminated beams for long spans, metal split-ring connectors for heavily stressed joints and special connectors for fastening rafters to plates, ridge connectors and other structural details are also finding their way into farm use.

Manufacturers of wood preservatives are locating supplies of treated poles and planks for sale in farm areas, due largely to the work of the Doane Agricultural Service in popularizing the use of treated poles in barns and other farm buildings.

Aluminum is the newest important building material to seek a farm market. Its outstanding virtue for farm buildings is its heat-reflecting value, which makes it desirable for roof and wall covering and insulation. Not all aluminum, however, is sufficiently corrosion resistant to be satisfactory for farm construction. To overcome this handicap the industry and government agencies have made field and laboratory studies of certain farm uses of aluminum and are now working on a standard specification suitable for building construction. Since the quality of aluminum cannot be determined by visual inspection, grades suitable for building construction should be marked for ready identification.

Manufacturers of steel, aluminum, plywood, glass, and other products are assisting the state experiment stations and USDA in efficient application of their materials to farm purposes. Manufacturers of prefabricated steel buildings are cooperating with state experiment stations and USDA in adapting a few standard building sizes to a variety of farm needs — an interesting study in standardization.

Industry and industrial research agencies are, of course, carrying on much research of a more general nature which is applicable to farm problems.

TAKING BUILDING INFORMATION TO FARMERS

To be useful to farmers, building research results must finally be incorporated into buildings. State experiment stations and USDA disseminate information through bulletins, leaflets, film strips, personal contacts with agricultural extension workers, teaching to students, and in other ways.

One of the principal ways of getting research into use, however, is through farm-building plans that are made available to farmers through what is known as the Farm Building Plan Exchange Service. In each of the four geographic regions of the country a cooperative farm-building-plan exchange has been set up. These regions are the Northeast, the Southern, the North Central, and the West. In each region a committee representing the state agricultural colleges selects building plans from all available sources that best meet the requirements in all or a major part of the region. The plans selected are circulated and criticized by each of the cooperating states in the region and by USDA. They are then put in shape for reproduction and general distribution.

Catalogs of the complete sets of regional plans are prepared and furnished to county agricultural agents and are available by purchase to lumber dealers and any others interested. A farmer wishing one of these plans can usually obtain it from the agricultural extension engineer at the state agricultural college. However, if he wishes a plan that is not generally used in the state or which is available only from one of the other regional exchanges, he can obtain it by writing to the key state in each region. The key state carries all plans in the regional exchange. The cost of this service to farmers is nominal.

The lumber trade associations and some other manufacturers publish booklets and plans showing correct use of their products on the farm. Many of these publications are developed with the assistance of agricultural engineers at the state agricultural colleges. The Better Farm Buildings Association, made up largely of representatives of building material and equipment manufacturers, prepares standardized basic designs, which are developed by its members in the materials which they produce.

CONCLUSION

In conclusion, I have reported a few examples of farm building research, in cooperation with industry and farmers, that increases livestock production, reduces storage losses and improves quality of farm products, decreases labor hours and costs, and makes farm work and farm living more enjoyable. As yet, these new developments are used by only a few of the more progressive farmers and there has not been time to fully integrate them with either crop-production methods or the design of the farmstead buildings as a whole. The status of farm-building progress now is a little like the situation 25 or 30 years ago when field machines designed for horses were used behind tractors. An immense amount of research and development was required to progress from that stage to the present rubber-tired, hydraulic-controlled, tractor-mounted equipment. No doubt something similar will be true of farm buildings.

Again, little progress has been made in mechanizing the construction of buildings on farms. More and better ways need to be found to use the power and equipment now available for farming operations to build walls, floors and roofs. Thus there is still great need for farm building research and application, and we can confidently expect that under reasonably normal economic and social conditions progress will continue, so that within a few years we will see building designs and practices that now seem revolutionary adopted for general use on farms.

LITERATURE CITED

1 ——— Farm Housing and Construction. U.S. Dept. Agr. Bureau Agr. Econ. Mimeo. 1952.

2 ——— 1950 Census of Housing. Preliminary Reports. Bureau of Census, U.S. Dept. of Commerce, 1952.

3 (a) Beyer, Glenn H. Farm Housing in the Northeast. Cornell Univ. Press, Ithaca, N. Y. 458 pp. 1949. (Continued on page 779)

Developing Tractor-Mounted Castor Bean Harvesters

By E. W. Schroeder and I. F. Reed
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CASTOR beans, as a crop, are not new in this country, but development through the past nearly 100 years has been hampered by problems encountered in harvesting. The fact that the plants tend to produce and ripen seed through a relatively long period and that in all but a few recently developed varieties the seed shatter from the early ripened spikes before the later spikes mature, made it necessary to hand-harvest the spikes as they matured without damaging the remainder of the plant if a high percentage of the possible crop was to be saved. This kind of crop did not appeal to American farmers, so most of the castor beans or oil used in this country was imported. Recognizing, however, that castor oil is essential in the equipment and materials of our modern civilization and the fact that our supply might be cut off, the federal government set up a basic seed production program during the period 1940-45. Equipment for hulling seed beans was developed and an effort made to harvest castor beans in Alabama with a grain combine. The beans were of a type that shattered readily and the combine was equipped only with the regular sickle and reel. Needless to say, the losses were excessive. About the time these tests were made, the countries furnishing castor beans to this country joined the Allies so our supply was assured and the seed-production program was dropped.

The conclusion drawn from these tests was that it would be necessary for the agronomists to develop castor bean plants relatively uniform in size and shape that would either retain the seed that ripen early until the entire plant was ready to harvest or that would ripen uniformly.

Though the U.S. Department of Agriculture withdrew from both the seed-producing and machinery-development programs for a period, a small breeding and seed-preservation program was maintained and commercial interests and state agencies continued development work.

Unsettled world conditions again emphasized the necessity for a domestic supply of castor oil so that the Department of Agriculture enlarged their castor-bean research program as discussed by D. L. Van Horn in his paper published in AGRICULTURAL ENGINEERING for November, 1952. The machinery phase of the program was set up and developed in cooperation with the Oklahoma Agricultural Experiment Station in July, 1950. The development of a castor-bean harvester suitable for and effective on the castor beans raised on non-irrigated areas, especially in Oklahoma and Texas, was given the first priority.

Field tests of a single-row pulled-type stripper, using the beater principle developed by Milo F. Arms, showed that these machines would not meet requirements for harvesting castor beans under Oklahoma and Texas conditions. Indications were, however, that the beater principle developed by Mr. Arms was effective. Permission was obtained to use this principle in the development of a castor-bean harvester for use in the Southwest.

The following objectives were believed essential and were kept in mind in the development of the initial and later model strippers: The strippers must (1) be tractor mounted and highly maneuverable, (2) be simple in construction and operation, (3) be economical to produce and operate, and (4) effectively recover a high percentage of seed.

D. L. Van Horn, agronomist, U.S. Department of Agriculture, and Oklahoma Agricultural Experiment Station; Phil Myers, agent, USDA, and W. J. Oates, agricultural engineer, Oklahoma Agricultural Experiment Station and the USDA, were primarily responsible for the first experimental single-row tractor-mounted model shown in Figs. 1 and 2. Work on this machine was started in August, 1950, and completed that same fall in time for harvesting tests. However, by the time the machine went into the field for tests, beans in Oklahoma had been killed by frost, making the plants extremely brittle. It effectively removed the beans from the stalk, but much seed was lost due to shattering. Broken limbs and other foreign matter were harvested with the beans. In December further tests were made with this same machine in California in plants which had not been killed by frost. Difficulties experienced in removing all the beans from the plants under these conditions led to the installation of an additional beater. Basic principles developed and built into this machine were later used to develop a two-row tractor-mounted production machine.

Because of the military need for castor oil, it was deemed necessary to produce two-row tractor-mounted harvesters incorporating the principles found effective in the single-row unit to insure growers of being able to harvest the castor beans they were being encouraged to plant. In January, 1951, it was decided that sixty of these machines were to be ready for the 1951 harvesting season. Since no two-row pilot model was available and there was not time available to permit building one, the Commodity Credit Corporation entered into a contract with the Boardman Company of Oklahoma City to produce these machines based on basic plans and specifications developed by and under the direction of I. F. Reed of the U.S. Department of Agriculture, assisted by and in cooperation with agricultural engineers of the Oklahoma Agricultural Experiment Station. The basic plans and specifications on which this contract was based were prepared between January 12 and February 20. Though it was realized that these restrictions were not desirable, it was necessary to limit the design to permit mounting on one make of tractor only and to omit a seed cleaner to enable getting machines for the 1951 harvest.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Kansas City, Mo., June, 1952, as a contribution of the Power and Machinery Division.

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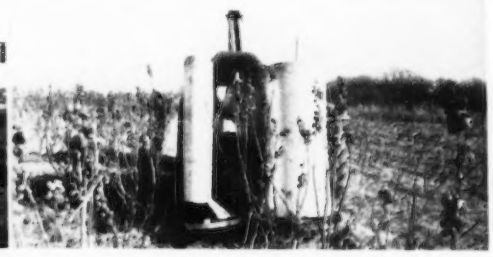

FIG. 1 (*Left*) Side view of single-row tractor-mounted stripper developed during the fall of 1950. • FIG. 2 (*Right*) Front view of single-row tractor-mounted stripper.

FIG. 3 (*Left*) Front view of 1951 model two-row tractor-mounted castor bean stripper. • FIG. 4 (*Right*) Side view of two-row tractor-mounted castor bean stripper.

The Boardman Company started on plans and the problem of locating materials immediately. Construction of some of the basic parts of the 60 machines was carried on while plans for detail parts were still being developed. The first two-row tractor-mounted harvester was completed and field tested August 8. These field tests showed that the machine would effectively harvest castor beans, though some minor difficulties were indicated. Minor design changes were made to overcome these difficulties and construction of the remaining 59 harvesters authorized in accord with the corrected drawings. The finished two-row stripper harvester is shown in the field in Figs. 3 and 4. The 60 harvesters were completed on schedule. Thus by complete cooperation of the Oklahoma Agricultural Experiment Station, the U.S. Department of Agriculture, and industry, the development of a castor-bean stripper from a single-row, tractor-mounted unit to a two-row unit was accomplished in less than seven months and sixty of the units were ready for the field six weeks later. It was realized that building 60 field machines without having field-tested a pilot model for one or more seasons involved risks, but conditions indicated that it was necessary to take these risks.

Since it was indicated that it would be necessary to build additional harvesters in 1952, six engineers from the U.S. Department of Agriculture and available personnel from the Oklahoma station and other agencies interested were assigned to follow or requested to observe the operation of these machines throughout the harvest season. Adjustments and changes that might improve operation and could be made in the field were tried.

In the meantime, basic research was continued in Stillwater by E. D. Baker, agricultural engineer of the USDA and the Oklahoma Station. One of the sixty machines was made available for controlled testing to obtain information that would be helpful for improving the design. Five acres of No. 101 seed increase beans (similar to Conner) were used in the tests. All tests were replicated. The ground speed ranged from 1.92 to 5.22 mph. Beater speeds ranged from 195 to 500 rpm. Analysis of the data showed no significant differences in treatments. A slight trend toward decreased loss at the higher ground speed and lower beater speeds was indicated. The average machine losses for all tests were 11 per cent.

Tests made in dwarf-type castor beans before frost showed that the stripper would effectively remove the castor beans from the stalks and that the beans harvested were relatively clean but some castor beans were lost through the throat of the machine. A change in the design of these seals reduced this loss. On November 1 a hard freeze hit the dry-land castor-bean-producing area. This killed the entire plant, causing the limbs to be brittle and the leaves to remain on. Since the strippers were not equipped with any type mechanism for cleaning the seed, many pieces of limbs and leaves were delivered to the wagon. This increased markedly the bulk of material to be handled and complicated conditions at the hulling centers. Other major troubles encountered or difficulties observed were:

1. Loss of beans, both through the seals and due to shattering
2. Trash tended to clog the radiator, causing heating of engine
3. Poor visibility for driver
4. Weight on front wheels excessive
5. Some gear and belt drives gave trouble.

Using all the information obtained during the 1951 harvest season, the front end of the experimental two-row tractor-mounted stripper was completely remodeled in Stillwater under the direction of E. D. Baker. The throat width was increased to 10 in. at the point where the plants enter and tapered to 3 in. at the front end of the inclined augers. The shielding was reshaped to widen the area receiving the plants as much as 8 in. to reduce shattering of the seed before the plants reached the beaters. Rubber seals (*Continued on page 779*)

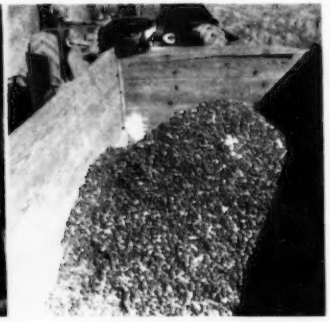

FIG. 5 (*Left*) The 1952 model castor-bean harvester showing saddle unit used for removing limbs, leaves, and other debris from picked beans. • FIG. 6 (*Center*) Right front gathering unit of 1952 tractor-mounted castor-bean harvester showing open-throat arrangement of the gatherers, augers for moving the picked beans, and use of hardware cloth to improve driver visibility and facilitate cooling the engine. • FIG. 7 (*Right*) Castor beans harvested near San Antonio, Texas, with the 1952 model tractor-mounted stripper.

The Challenge and Rewards of a Design Career

By Lawrence H. Skromme
MEMBER ASAE

DOWN through the ages, men have always been strongly motivated when confronted by a challenge. A strong challenge to his abilities has often been the factor which has spurred a man on to great deeds and accomplishments. Carrying this line of thought to its conclusion, Arnold J. Toynbee, the famous historian, built a whole theory of history* around the simple idea of challenge and response. Civilizations rise to high levels, according to his theory, when challenged by difficult situations and problems, while insufficient challenge in the form of easy living with little demand upon man's ingenuity results in a civilization which never achieves a high level of culture.

Mountaineers find an impelling challenge in a lofty peak which will not let them rest until they have scaled the summit. Other men have likewise set forth to sail uncharted seas — and it is of interest to note that one of the outstanding oceanic explorations was carried out by the British group which put out in a vessel christened the "HMS Challenger." So strong has been the motivating power of a challenge that many men have accepted such challenges at the risk of losing their security, their friends—even their lives, whether it was the challenge to a duel or of an unscaled peak such as Mt. Everest.

It is my strong contention that the field of farm machinery design presents a greater challenge to an engineer's ability than any other present field of engineering endeavor. It is understandable that you would think it strange to see such a statement concerning an engineering field which in the past was looked upon with some disdain, a field in which the majority of machines were once designed, not by engineers, but by mechanics and patternmakers who had a little more flair for creative work than their fellow workers. Because of this background, I would like to present my thoughts in support of the above contention.

It is obvious that in order to inspire a man to outstanding action a challenge must be difficult to meet successfully. Therefore, the basis of the aforementioned contention must be my strong belief that farm machinery is the most difficult mechanical design field to meet successfully. With such new developments in the automotive, aircraft, and other mechanical design fields, as atomic engines, jet planes, hydraulic transmissions and torque converters, intricate production machines, gigantic printing presses, and up to the huge ocean liners, it may be somewhat difficult to understand why I feel that the successful design of farm machinery is the most difficult and thus the most challenging of all.

Primarily my defense for this position lies in my strong belief that the difficulty of attaining success in any design field can be measured by the variations in extent and severity of the required conditions which must be successfully met in operation by the unit designed. To those intimately familiar with the requirements it is almost self-evident that the range of conditions to be met successfully by farm machinery vary more and are more severe than for any other class of mass-produced commercial mechanical equipment. The variations of conditions to be met by farm machines range through drastic extremes in all of the many factors affecting operation, such as soils, topography, crops, climate, daily weather, seasons, and skills of operators. Because of the precise timing required in successful farming operations, the work of an agricultural machine must be performed in a minimum amount of time; and, because of the nature of farming itself, the machine must be produced at an absolute minimum cost so that the limited usage received will not put the cost per hour of use into a range that is prohibitive.

Perhaps a little further discussion of these conditions which vary so greatly would aid in seeing the true picture and give a better measure of this challenge. All agricultural engineers know the extreme ranges in type and texture of the multitude of different soils which range from the loose, light sands to the tight, heavy clays. Also, great variations exist in handling or tilling even the same soil due to changes in moisture content alone. By contrast with the soil, the air through which an airplane operates is a very stable medium, and the surface of a highway which an automobile must traverse changes but a relatively small percentage due to variations in moisture and other conditions.

Unlike the production machine which the millwrights anchor firmly to deep foundations, the farm machine must perform very similar operations in the field, and thus maneuverability and portability become prime considerations. Furthermore, the agricultural machine cannot utilize a pair of steel rails, such as a new diesel locomotive, or even use a smooth highway, but must operate over the fields as they lie. The topography and terrain over which agricultural machines must traverse varies from the flat and level flood plains and irrigated areas, to the small, steep hillside fields of New England, Pennsylvania, and other mountain states. Even within the fields such apparently minor variations in topography as irrigation checks and borders, terraces and natural hazards such as wild animal dens or sink holes, will be encountered and must be taken in stride.

The many different varieties of crops, and the wide variation in size, stand, and yield of the same variety of crop, is also well known to the farmer and the agricultural engineer. The dry, short-strawed grain from the Great Plains dry-farming areas must be handled with the same combine harvester as the lush long-strawed grains of the irrigated mountain plateaus. The same combine must also handle the clover seed crop which has millions of tiny seeds per bushel, as well as the peas and large beans which form the large seeded species of the same legume family. The tough native prairie grasses

The author says agricultural engineers produced this New Holland tractor mower, which is not just a tractor version of the old horsedrawn type but a new design adapted to high-speed operation

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Kansas City, Mo., June, 1952, as a contribution of the College Division.

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*A Study of History by Arnold J. Toynbee, Oxford University Press, 1934.

of the western Nebraska sandhill country must be cut with the same type of mower that handles the uniform alfalfa of the irrigated sections, and such extreme variations in conditions sometimes exist on the same ranch or farm.

Agricultural machines must operate successfully under wide ranges of climate, from the hot and humid Texas Gulf Coast to the dry, cool, and short summers of the northern Canadian plains provinces. Of more immediate concern to most farmers, however, is the variation in daily weather cycles which disrupt his farming operations, and yet under which many machines must operate successfully. Not only does the weather vary from day to day, but often an entire season will differ greatly from the normal, or average, and cause further variations in the crops and in condition of the crop, which makes successful performance of the machine vastly more difficult. Also, since so many field operations can be performed only when weather conditions are suitable, the rapid changes in daily weather also increases the complexities of properly timing the already difficult schedule of field operations and so often continued inclement weather forces the machines into severe round-the-clock usage to finish the operation before it gets too late in the crop season.

The one major condition where we are certain we have the dubious distinction of surpassing any other field is in the lack of skill of many farm machinery operators, and the neglect and abuse which they give their equipment. Automotive drivers must at least secure a license, and airplane pilots must pass stiff and rigorous examinations before being permitted to handle commercial craft, and yet we know that too many of our farm machinery operators merely learn how to put everything "in gear" and then take off at excessive speeds without ever looking around. Adding to this difficulty is the pressure under which much of the farm work must be done, which tends to cause even a good operator to neglect proper adjustment and lubrication.

Lack of skill in the operator is not so critical when some of the simpler farming operations are being performed, but we are also well aware of the extreme complexity of many of the agricultural harvesting operations where the machines must perform on a par with, and often do even more difficult tasks than most industrial machines, many of which just cannot be done satisfactorily without proper adjustment, maintenance, and skilled operation. Even some of the earlier agricultural machines which we now look upon as almost obsolete, such as the old grain binder, had an extremely complex mechanical sequence of difficult operations to perform in cutting and gathering the grain and automatically tying the bundle, and many of these interrelated mechanical operations had to be timed together within a fraction of a second.

Climaxing this list of conditions which must be successfully met by agricultural machinery is the requirement of absolute minimum cost plus long life, which is required in order to keep the fixed charges as low as possible per hour of use, and thus economically justify this entire effort. Again, each agricultural engineer knows only too well the very low average hours of usage for the typical farm machines. Machine tools in industry are used thousands of hours per year, while their counterparts in the agricultural field are many times used less than a hundred. So the initial cost must be kept at the lowest possible figure without sacrificing that all-important performance under these extreme ranges and variations of conditions. This means that instead of using ample quantities of the finest alloy steels, and allowing wide margins in the factor of safety, as the machine tool designer can do, the farm machinery designer must utilize the minimum amount of the lowest cost materials available and permit the widest possible manufacturing tolerances which will still result in top field performance. Furthermore, all parts must be designed so that they may be economically produced with a minimum of time and effort by modern mass-production methods.

Like the old minister who, when asked the secret of his successful sermons, replied, "Well, first I tell 'em what I'm going to tell them — then I tell them — and, finally, I tell them what I told them."— Perhaps a preview of these factors would be helpful. I contend that the farm machinery design field is the most challenging because it is the most difficult. It is most difficult because farm machines have to meet the widest range in the greatest number of variable conditions of any present-day mechanical units. Among others, these variations range through the widest possible extremes in the following major conditions and factors:

1 Soils	5 Daily weather and seasons
2 Topography	4 Climate
3 Crops	6 Skill of operators

And to meet this multitude of different conditions, the farm machine can still not be a "supermachine", designed with little regard for cost, but must meet rigid requirements for low initial and operating costs.

When compared with such other fields which the popular concept has long regarded as difficult, I do not find that they are really comparable on this basis. For example, the airplane must meet only the variable conditions due to one factor — weather, with the other conditions rather readily determined and remaining fairly constant. Also, the airplane designer has never had to be too concerned with the cost of manufacture of his product.

In the paper, entitled "The Graduate Engineer in Farm Equipment Design," published in the September (1952) issue of AGRICULTURAL ENGINEERING, Charles J. Scranton has given an excellent presentation of how a modern engineering organization in the farm machinery industry operates to meet successfully this challenge. He is well qualified to discuss this subject since he has personally built one of the finest engineering organizations in our industry, which fact is attested by the performance and quality of the tools produced from designs worked out by his group. His organization is among the leaders of the many organized groups of farm machinery design engineers who have been spurred on by the challenge of this difficult work to develop the new designs which are mechanizing agriculture and thus exerting a profound influence on the course of our present civilization.

Coming along as somewhat of a brash, young upstart in this field, I have often differed with Mr. Scranton on certain matters, such as details of standardization and so on. However, I differ not one whit with him in his thoughts on the role of the graduate engineer in farm equipment design and the general principles of effective engineering organization and

(*Left*) Modern streamlined design of farm machines shows up in this New Holland Model 77 hay baler. • (*Right*) The need for a machine to chop grass for hay and silage presented a challenge to agricultural engineers which resulted in this New Holland field forage harvester.

operation which he outlined in his paper. Since Mr. Scranton has so clearly shown how industry sets up a design and development organization to do this work, I will not discuss that phase of the subject, but will instead consider some of the rewards which can come to the man who successfully meets the challenge presented.

Since so many of us think first of monetary rewards, I will discuss salaries briefly. When I started in this work, the design engineer was perhaps the most poorly paid professional worker in America, in accordance with what he was expected to accomplish. However, I am happy to be able to say that this situation has now entirely changed, and that design engineers are now paid relatively as well, or perhaps a little better, than other technical and professional workers. In fact, the starting rates for new engineering graduates are perhaps the highest of any of the fields open to college graduates, being three to five times higher than they were before World War II. Naturally there are some who think that these rates may be too high for either the young graduates' or the industry's good. However, time has a way of taking care of such things and in a few years the starting rates will no doubt level off to an equitable plane. Compensation for experienced men has also increased, and while this rise has not been quite as spectacular as has the starting rates for young graduates, the earning scale is now at a level which I feel compensates a man well for his efforts, and compares very favorably with all other fields.

On the other hand, men do not accept most challenges because of the monetary reward which may be held out to them. There is no pot of gold at the top of every mountain peak to lure the climbers on, so it must be the inner satisfactions of such accomplishment that spurs the climber to achieve the summit. The first such satisfaction which the farm machinery designer receives comes when he sees the design actually take form in the experimental shop. In addition to the solid satisfaction of seeing a physical unit actually take the shapes which he conceived, there is the added lure of mechanical operation which has fascinated most men since the wheel was first invented. Then to the field, and when the design engineer finally sees his machine actually perform the many difficult operations successfully—no matter how the conditions vary — he receives his first real reward in the satisfaction of seeing his unit work "as intended".

SATISFACTION FROM WORK WELL DONE

The next such satisfaction with which the designer of a successful item of new farm equipment is rewarded comes when the extensive field testing is complete and he first sees the many new machines coming down and off the production lines. The engineer knows that many thousands of dollars have been spent for material and hundreds of thousands of dollars for the tools, dies, fixtures and patterns that are so necessary in low-cost mass production, and that for months many production engineers and production supervisory personnel have labored to make the preparations and set up the lines for producing this design. By this time the amount invested in new farm machinery design has usually ranged up into millions of dollars of his employer's capital — all this before a single dollar has been realized in sales. Furthermore, everyone concerned knows that these sales will not be realized unless the machine performs to the farmer's satisfaction. While this places a terrific responsibility on the engineer, it also gives him the satisfaction of knowing that this much confidence has been so concretely expressed in his ability. In addition, he sees and knows that other men are earning their daily bread by producing the machines which he helps create, and to be able to see this actually take place and observe the shiny new machines successfully pass its inspection test at the end of the line, gives the designer another deep inner satisfaction of accomplishment.

However, there is more in store for the man who has put so much of himself into a mechanical design. I believe that many of you have been in the field with a farmer when his machine was not performing satisfactorily, and perhaps have heard him threaten what he would do to that factory engineer if only he were there. In contrast, the engineer who has successfully met the challenge and who may come unheralded upon a farmer operating *his* machine can get his supreme satisfaction of accomplishment when the farmer greets him with comments like: "Boy, the fellow who designed this machine really did a fine job! It works just swell and I wouldn't sell it for any price if I couldn't get another." This is then a deep and satisfying reward to the designer who has successfully met a difficult challenge and, in so doing, has made a major contribution to agriculture, the most basic of all industries producing food and fibre to feed and clothe mankind.

Tractor-Mounted Castor Bean Harvesters

(Continued from page 776)

were run the full length of the inclined augers to reduce throat losses. The framing was redesigned to give the operator better visibility, and with use of lighter sheet metal, the weight was reduced. Relocation of the lift and use of 3½-in augers, instead of chain conveyors, further reduced weight, especially on the front wheels. Tapered augers in front of the large augers were used to make possible the harvest of seed close to the ground.

Changes, most of which were tried on the experimental machine at Stillwater, have been built into the 1952 harvester shown in Figs. 5 and 6. Seals have been improved, shielding has been reshaped to reduce seed loss at the front of the machine and improve driver visibility, the drag chains on each side of the row at the front of the machine have been replaced by small auger units, drives and lift have been simplified, a cleaner has been added, and the weight carried on the front wheels has been reduced markedly. Castor beans harvested with this unit are shown in Fig. 7. In addition to these changes needed for the plains area, the front end of the beater mechanism has been lowered to make it suitable for harvesting castor beans raised in irrigated areas.

Developments in Farm Structures

(Continued from page 778)

(b) Nickell, P., Budolfson, M., Liston, M. and Willis, E.: Farm Family Housing Needs and Preferences in the North Central Region. North Central Regional Publication No. 20. Iowa Agr. Expt. Sta. Res. Bul. 378, 173 pp. 1951.

(c) Farm Housing in the South. Southern Coop. Series Bul. No. 14. Ala., Ark., Ga., Miss., S.C., Tenn. and Va. Agr. Expt. Stas. and Bureau of Human Nutrition and Home Economics, U.S. Dept. Agr. 1951.

(d) Housing Needs of Western Farm Families. Western Cooperative Series. Research Report No. 1, 1952.

4 Environmental Physiology Series. Missouri Agr. Expt. Sta. Res. Buls. I through XIX.

5 Thompson, H. J., and Stewart, R. E.: Heat and Moisture Exchanges in Dairy Barns. AGRICULTURAL ENGINEERING. 33.4: 201-204, 206. 1952.

6 Ota, Hajime, Garver, H. L., and Ashby, Wallace: Heat and Moisture Production of Laying Hens Under Simulated Farm Poultry House Conditions. U.S. Dept. Agr. Mimeo. (To be published in AGRICULTURAL ENGINEERING.)

7 Heitman, Hubert, Jr., and Hughes, E. H.: The Effects of Air Temperature and Relative Humidity on the Physiological Well-Being of Swine. J. An. Sci. 8: 171. 1949.

8 Bond, T. E., Kelly, C. F. and Heitman, Hubert Jr.: Heat and Moisture Loss from Swine. AGRICULTURAL ENGINEERING. 33.3: 148-152, 154. 1952.

9 Kelly, C. F. and Ittner, N. R.: Artificial Shades for Livestock in Hot Climates. AGRICULTURAL ENGINEERING. 29.6: 239-242, 250. 1948.

10 Giese, Henry and Bond, T. E.: Design of a Plate-Type Heat Exchanger. AGRICULTURAL ENGINEERING. 33.10: 617-622, 1952.

11 Witzel, S. A. and Derber, D. W.: Engineering Phases of Dairy Barn Research, 1941-1951. AGRICULTURAL ENGINEERING. 33.10: 635-642, 1952.

12 Taylor, J. G.; Orem, M. T.; Doyle, L. P., and Vestal, C. M.: Fundamentals of Infrared Brooding of Pigs. AGRICULTURAL ENGINEERING. 33.4: 213-215. 1952.

13 Cleaver, Thayer: Time-Travel Studies on Dairy Farms. AGRICULTURAL ENGINEERING. 33.3: 147-149, 142. 1952.

14 Robinson, R. N., Hukill, W. V. and Foster, G. H.: Mechanical Ventilation of Stored Grain. AGRICULTURAL ENGINEERING. 32.11: 606-608. 1951.

15 Davis, Roy B., Schoenlebet, L. G. and Campbell, L. E.: Drying Forage by Forced Ventilation. U.S. Dept. Agr. Farmers' Bul. 2028, 22 pp., illus. 1951.

16 Sainsbury, G. F.: Cold Storage of Apples in the Pacific Northwest. AGRICULTURAL ENGINEERING. 31.9: 458-460, 462, 464. 1950.

An Analysis of Branching Flow in Pipes

By Robert A. Aldrich and Aldert Molenaar
MEMBER ASAE

A STUDY of the flow of water in a portable sprinkler irrigation line, where rotating sprinklers are spaced at intervals along the line, includes the problem of outward-branching flow. Several investigators (see appended references) have analyzed the hydraulic characteristics of outward-branching flow, each with a slightly different approach and, generally, with different results. This paper presents an analysis of the problem of outward-branching flow applied to a single branch.

The conventional type of sprinkler irrigation line has the sprinkler risers attached to the couplers. Normally turbulence occurs in the region of a coupler, which results in loss of head. Under conditions of outward-branching flow a decrease in mean velocity occurs in the main pipe immediately below an outlet. The decreased velocity head is converted to pressure head, thus causing a small pressure gain.

Since the main purpose of the study was to analyze the pressure gain across a riser outlet, it was necessary to eliminate the head loss occurring in a conventional type of sprinkler-line coupler. A machined plastic coupler, rigidly assembled, satisfied this requirement (Fig. 1).

The pressure gain across an outlet, based on the pressure-momentum and energy principles, can be expressed in equation form. By applying the pressure-momentum principle to the fluid between sections 1 and 2 (Fig. 2), a general equation is developed:

$$(p_2 - p_1)A_1 = \rho Q_2 V_2 - \rho Q_1 V_1 - F$$

where F is fundamentally the unbalanced force exerted on the water in the region of the riser. From the continuity equation

$$Q_1 = V_1 A_1 \text{ and } Q_2 = V_2 A_2$$

since there is no change in pipe size between sections 1 and 2, $A_1 = A_2$. Therefore

$$(p_2 - p_1)A_1 = w Q_2^2/gA_1 - w Q_1^2/gA_1 - F$$

or

$$(p_2 - p_1)/w = (Q_2^2 - Q_1^2)/gA_1^2 - F \quad . \quad . \quad . \quad [1]$$

Referring to Fig. 2, in the application of the energy principle, if the pipe and riser are assumed horizontal, the elevation energy may be disregarded in determining the total energy at each section. By this assumption the energy at section 1 is

$$w Q_1 (V_1^2/2g + p_1/w),$$ and the energy at section 2 is

$$w Q_2 (V_2^2/2g + p_2/w).$$

Bernoulli's principle states that the energy of the fluid at section 1 will equal the sum of the energies at sections 2 and 3 plus the energy lost in moving the fluid from section 1 to sections 2 and 3. In equation form

$$Q_1 w\left(\frac{V_1^2}{2g} + \frac{p_1}{w}\right) = Q_2 w\left(\frac{V_2^2}{2g} + \frac{p_2}{w}\right) + Q_3 w\left(\frac{V_3^2}{2g} + \frac{p_3}{w}\right) + e_L \quad . \quad . \quad [2]$$

where e_L is the total energy lost in the region of the riser. The sections are assumed near enough to the side outlet that pipe friction may be ignored in the energy loss term. Two assumptions are made in order to evaluate the energy loss in the region of the riser outlet, as follows:

1. The energy loss between sections 1 and 2 can be expressed as a sudden expansion loss.

2. The energy loss between sections 1 and 3 is a function of the velocity head in the riser.

Expressed as an equation

$$e_L = \frac{Q_2 w k_1 (V_2 - V_1)^2}{2g} + \frac{Q_3 w k_2 V_3^2}{2g} \quad . \quad . \quad . \quad [3]$$

k_1 and k_2 are essentially functions of boundary conditions. By applying the momentum principle to the riser section the following equation results:

$$p_m A_3 - p_3 A_3 = \rho Q_3 V_3$$

Assuming that $p_m = (p_1 + p_2)/2$ (an assumption subsequently proved by laboratory test), p_3 may be expressed in terms of p_1, p_2, and V_3 thus $p_3 = (p_1 + p_2)/2 - V_3^2$ . . . . . [4]

Combining equations [2], [3], and [4] a final equation for evaluating the change in pressure head across the side outlet is obtained.

$$\frac{p_1 - p_2}{w} = \left[\frac{1}{2Q_1 - Q_3}\right]\left[\frac{Q_1 V_1^2}{g} - \frac{Q_2 V_2^2}{g} - \frac{k_1 Q_2 (V_2 - V_1)^2}{g} + \frac{Q_3 V_3^2}{g} - \frac{k_2 Q_3 V_3^2}{g}\right] \quad . \quad [5]$$

This paper was prepared expressly for AGRICULTURAL ENGINEERING. Approved as Scientific Paper No. 1141, Washington Agricultural Experiment Stations, Project No. 855.

The authors: ROBERT A. ALDRICH and ALDERT MOLENAAR, respectively, junior agricultural engineer and agricultural engineer, Washington Agricultural Experiment Stations, Pullman.

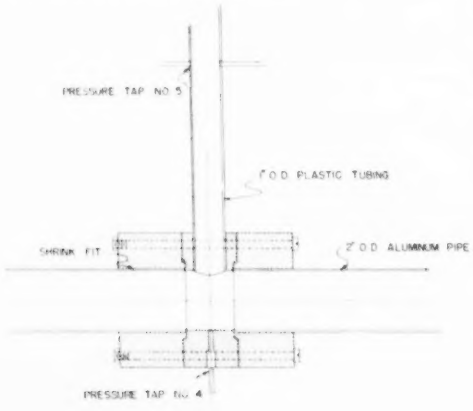


FIG. 1. Sectional view of plastic coupler.

EXPERIMENTAL PROCEDURE

The equipment for the research consisted of two 10-ft lengths of 2-in aluminum tubing joined by a plastic coupler. This coupler was made in three parts (Fig. 1). The end sections were machined to a shrink fit on the tubing and the center section, containing a short length of 1-in plastic riser pipe, was machined to an inner diameter equal to that of the aluminum tubing.

Piezometer taps were placed in the main pipe, three upstream and three downstream from the riser. Two taps were

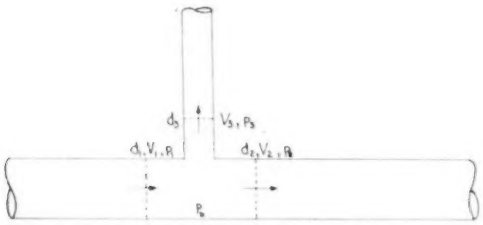


Fig. 2 Definition sketch for branching flow

placed in the riser, opposite each other, and another in the main pipe directly opposite the riser outlet as shown in Fig. 1. Since both riser taps registered equal pressures, only one was used. All piezometer taps were connected to a water manometer by means of plastic hose. Fig. 3 shows a typical example of piezometric heads occurring in the main 2-in tubing when a part of the flow was diverted at the riser outlet.

The discharge through the riser, Q_3, was measured with a conventional water meter, and the flow quantity downstream from the riser, Q_2, was determined by means of weighing tanks. The sum of the measured quantities was considered to equal Q_1.

Flow through the riser Q_3, was varied from 2.5 gpm to 15 gpm, and the ratio of outlet discharge to total flow, r_q, was varied from 0.0315 to 1.000.

Results of the laboratory tests are graphically represented in a dimensionless plot (Fig. 4), where the ratio of change in hydraulic gradient to twice the velocity head upstream from the outlet, $(\Delta Z/V_1^2)/g$, is plotted as the ordinate against the ratio of riser discharge to the total flow, r_q, as abscissa.

DISCUSSION

The equation developed from the application of the pressure-momentum principle could be used equally as well as that derived from the energy principle for evaluating the pressure gain across a side outlet, but there is no apparent satisfactory method for developing an expression for the unbalanced force in the region of the riser outlet. This force could not be determined experimentally with any degree of success.

The final equation obtained from the application of the energy principle is cumbersome to operate in its present form, but with some simplification it may be written in a dimensionless form.

$$\frac{\Delta Z}{V_1^2/g} = \left(\frac{r_q}{2 - r_q}\right)\left[r_q^2\left(1 + \left(\frac{d_1}{d_3}\right)^4\left\{1 - k_2\right\}\right) - r_q\left(3 + k_1\left\{1 - r_q\right\}\right) + 3\right] \quad [6]$$

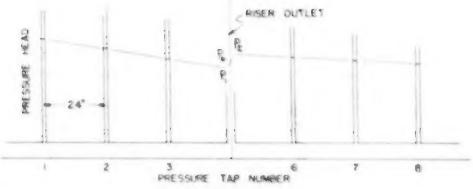


Fig. 3 Typical hydraulic grade line in main pipe

The ratio of pressure head to twice the velocity head is expressed as a function of the discharge ratio, a diameter ratio, and the head loss coefficients, k_1 and k_2. The discharge ratio can be set and the diameter ratio is constant for any particular pipe and riser combination. For a particular set of conditions, therefore, the only terms to evaluate for a complete solution are the two head loss coefficients.

Preliminary trials of k_1 and k_2 indicated that single values for the head-loss coefficients would not produce a curve that would agree with the experimental results. Therefore, a relationship between the coefficients and the flow properties had to be established from the experimental data. The discharge from the riser is chiefly a function of operating pressure in the main pipe and of boundary geometry. Therefore, the coefficient of the head-loss term between the main pipe and the riser should be determined by the geometry of the outlet for any given operating pressure. For specific pipe and riser dimensions and constant operating pressure the coefficient k_2 will then be constant for all values of r_q.

Examination of the equation in its dimensionless form shows that, when the discharge ratio is unity, the coefficient of k_1 becomes zero, and the resulting equation contains only k_2 as an unknown quantity. At r_q equal to unity, the experimental curve has the value of 0.32. Substituting this value in equation [6], k_2 is determined to be 1.032. The value of k_2 thus determined was assumed to remain constant for the conditions of the experimental tests. With k_2 established, values of k_1 could be obtained by using the experimental relationship between r_q and $(\Delta Z/V_1^2)/g$. Evaluating k_1 in terms of r_q, equation [6] then becomes the equation of the experimental curve.

If the relationship between k_1 and r_q is expressed in exponential form, i.e., $k_1 = m r_q^a$, then a plot of r_q versus k_1 on a logarithmic coordinate system will appear as a straight line, with a being the slope of the line and m the intercept. When $r_q = 1$, a log $r_q = 0$ and log $k_1 = \log m$. From the log plot of Fig. 5, m is determined to be 1.43 and a to be -0.81. The complete equation relating k_1 and r_q is then

$$k_1 = 1.43 r_q^{-0.81} \quad [7]$$

(Continued on page 783)

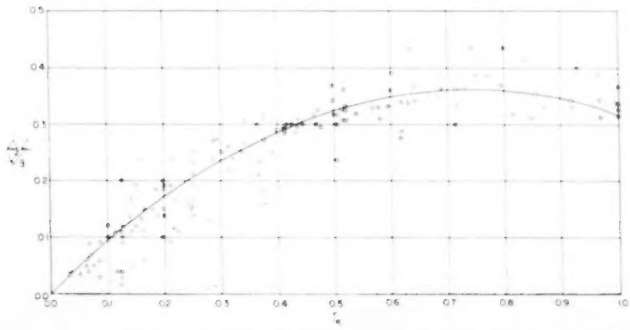
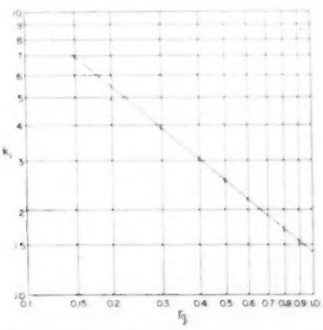


Fig. 4 (Left) Graphical presentation of experimental data • Fig. 5 (Right) Graphical solution of $k_1 = m r_q^a$



Forced vs. Natural Draft Ventilation in Poultry Houses

By W. J. Promersberger and Reece L. Bryant
MEMBER ASAE

POULTRY HOUSE ventilating systems are numerous and offer special problems in various sections of the country. In an effort to determine the operating characteristics of several ventilating systems and their effect on laying hens, the North Dakota Agricultural Experiment Station studied three systems that are in common use. In the fall of 1946 we began taking data in three poultry houses that are identical except for the ventilating system. Each house is 18 x 18 ft in size with a shed roof. Drop siding is used on the outside of the 2 x 4 studs. Shiplap and vapor-seal paper are used on the inside. The stud spaces and ceiling are filled with loose-fill insulation. All pens have concrete floors. Deep litter, about 6 in. was used in all houses. Old litter was removed in the spring and new litter added at the beginning of each season.

A fan ventilating system, a slot system, and a muslin-front system were used. There are about 33 sq ft of glass area on the south side of the houses having the fan ventilating system and the slot system. The muslin front house has 21 sq ft of glass area on the south side and 12 sq ft of muslin curtains. All houses have about 7 sq ft of glass area on the north side, located under the roosts.

Each test season was considered to be the four-month period from December to March inclusive, except in 1948-49 when the period from January to April was used.

Eighty White Plymouth Rock pullets were housed in each unit. They were distributed as evenly as possible between houses on the basis of age, pedigree, weight, and apparent vigor.

The rations given to the birds were formulated to meet all known requirements for laying and breeding hens. All birds in the experiment received the same ration during each test period.

Data taken included maximum and minimum temperatures near the floor at bird level, air flow, moisture content of litter, egg production, mortality, feed consumption, body weight, and egg hatchability. The relative humidity was checked occasionally with a spinning psychrometer.

RESULTS

Temperature. A statistical analysis of maximum and minimum temperatures taken near the floor at bird level revealed that the three different ventilating systems used did not produce any significant differences in average daily temperature or daily spread in temperature. Temperature and humidity conditions in the three houses were quite similar. Significant day-to-day variation in temperature occurred throughout the experiment since no attempt was made to maintain uniform temperatures. Temperatures in each house usually varied from about 32 F to 50 F depending upon outside weather conditions. On extremely cold days the inside temperature dropped to below freezing in all houses.

Egg Production. The three ventilating systems did not produce any significant differences in eggs per hen per day. However, in those years where higher daily temperatures were recorded, greater daily spread in temperature and greater egg production were observed. Average daily temperature did not account for any day-to-day fluctuations in egg production. However, spread in temperature from day to day affected egg production significantly. This suggests that fluctuating temperature serves as a stimulant for greater egg production. More data is necessary to definitely establish this fact.

Mortality. There were no significant differences in mortality between houses.

Feed Consumption. The data show that feed consumption varied with egg production rather than with the type of ventilation system used. When all trials of the experiment are considered, it required approximately 6.7 lb of feed to produce one dozen eggs.

Body Weight. The method of ventilation had little effect on the gain in weight of the birds. Those in the fan-ventilated house gained slightly less than those in the other houses in three of the four years, but the differences were not great enough to be significant.

Egg Hatchability. The hatch of fertile eggs was higher in the fan-ventilated house in three of the years and only slightly less in the other year. For the entire period of the experiment the house with the slot ventilation gave the lowest hatch of fertile eggs. The per cent of fertile eggs also was lowest in the slot-ventilated house and highest in the house with the fan ventilation.

Air Flow. Air-flow measurements indicated that the fan in the fan-ventilated house delivered from 1.5 to 2.5 cfm per bird depending on adjustment. A thermostat was used to shut off the fan when the poultry-house temperature dropped to about 35 F. During cold weather the thermostat shut off the fan for several short intervals each hour. An accurate record of the length of time that the fan did not run during each hour was not kept, but this time probably varied from 10 to 30 min. On extremely cold days the fan probably did not run for periods of an hour or more. During milder weather the fan ran continuously.

Air movement on the floor of the three houses was also checked. In the fan-ventilated houses the instrument did not register on the floor, indicating negligible air movement. In the houses having gravity ventilating systems the air movement was often as high as 50 fpm. This air movement had no apparent effect on the birds.

Moisture Content of Litter. Litter moisture samples were taken once a week in two locations in each house. The taking of samples was usually begun the first of December. At this time the moisture content of the litter was about 25 per cent on a wet basis in all pens. This litter moisture increased gradually until a peak of about 40 to 45 per cent was reached late in February or in March. There was little difference in litter moisture in the various houses. All were excessively wet, especially during the latter part of the winter.

Excessive litter moisture seems to be a general problem in poultry houses. Apparently, with the construction used in the test houses and previously described, it is not possible to move enough air through a poultry house to remove moisture and yet keep the temperature above freezing. This problem needs further study.

Figs. 1, 2 and 3 illustrate the types of ventilating systems used and a summary of the data is shown in Table 1.

TABLE 1. SUMMARY OF BIRD PERFORMANCE DATA
Average of Four Seasons, 1946-1950

	Type of ventilation		
	Muslin front	Slot system	Forced air
Egg production, per cent	59.1	58.0	60.3
Mortality, per cent	16.9	17.9	16.2
Hatchability of all eggs, per cent	68.2	67.6	64.3
Feed consumption per bird for test period, lb	45.7	44.3	46.1
Feed per dozen eggs, lb	6.93	6.75	6.70
Average gain in weight of birds, lb per bird	0.42	0.39	0.36

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1951, as a joint contribution of the Farm Structures and Rural Electric Divisions.

The authors, W. J. PROMERSBERGER and REECE L. BRYANT, respectively, agricultural engineer and poultry husbandman, North Dakota Agricultural Experiment Station, Fargo.

FAN PERFORMANCE

In working on any project there are always some things about equipment available that one can improve or for which one can suggest improvements. It is believed that continuous fan operation is highly desirable in all ventilating systems because ventilation is necessary at all times. Also, if a fan is allowed to stop, it will sometimes freeze in position during cold weather and then fail to start when the thermostat again turns it on. Our experience with exhaust fans installed in metal ducts has not been completely satisfactory. A ring of ice builds up on the inside of the metal exhaust duct and when the fan is stopped by the thermostat the tips of the fan blades freeze to this ring of ice. The result has been some burned-out motors, when not properly protected, and poor ventilation. A fan that would run continuously, but at two speeds, should eliminate this difficulty.

Two-speed fans are available, but the fan capacity at the low speed is much too high. The low speed should give a capacity of about one-third that of the high-speed capacity. We have, on an experimental basis, installed a resistance unit and thermostat on a fan with a shaded-pole motor in such a way that, when the thermostat went to "off" position, it put the resistance unit in series with the fan motor and reduced its speed to the point where it delivered about one-third of its original capacity. This system worked quite well. On larger installations we have used two fans. A small one to run continuously and deliver about one-third of the necessary capacity and a large one controlled by a thermostat to deliver about two-thirds of the necessary capacity. This system has worked out quite well.

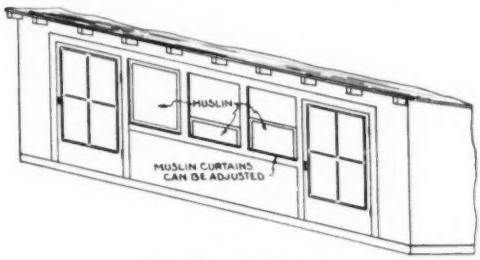


Fig. 1 The muslin front system

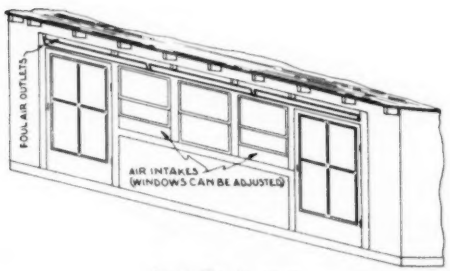


Fig. 2 The slot system

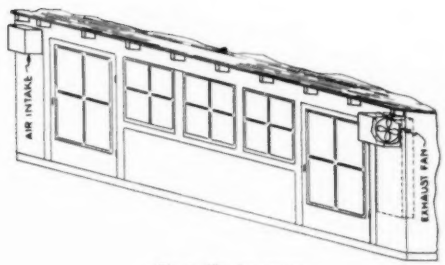


Fig. 3 The fan system

Metal shutters on fans have not given much trouble. They sometimes freeze in the closed position, but when the fan starts the warm air blowing against the shutter usually thaws it out and it will then open. We have also used homemade canvas shutters with good results.

SUMMARY

The three ventilating systems used produced no significant differences in egg production, mortality, feed consumption, and gain in body weight.

The hatchability of all eggs was highest in the muslin-front house, but the hatch of fertile eggs was highest in the fan-ventilated house. However, these differences were not significant.

Litter became excessively wet in all houses.

Generally speaking, fan systems require much less attention from the caretaker. However, in cold weather they sometimes frost up and fail to operate.

Branching Flow in Pipes

(Continued from page 781)

If, in equation [6], k_2 is replaced by its numberical value, 1.032, k_1 by its value as determined in equation [7], and $(d_1/d_3)^4$ by its value for the conditions in the study, $(d_1/d_3)^4 = 21.08$, a final equation can be written with the energy ratio as a function only of the discharge ratio.

$$\frac{\Delta Z}{V_1^2/g} = \left(\frac{r_q}{2-r_q}\right)\left[0.325\, r_q^2 - r_q\left(1 + 1.43\, r_q^{-0.81}\left[1-r_q\right]\right) + 3\right] \quad [8]$$

This is an empirical equation, true only for conditions similar to those used in developing it. The equation does illustrate that the coefficients of the head loss terms are functions of the flow and of the geometry of the outlet, and that they can be evaluated by laboratory tests in terms of these properties.

The general equation [5] expresses the true relationship for all diameter ratios and operating pressures. For each set of imposed conditions, however, values of the coefficients k_1 and k_2 will have to be experimentally determined.

The results of this study do provide a means for analyzing the pressure gain occurring across a sprinkler riser outlet. It should now be possible to introduce an additional head-loss term to represent the loss due to turbulence within a sprinkler line coupler. This term will probably be of a form similar to that of other minor loss terms used in pipe-flow analysis, but its character will likely need to be determined by laboratory tests.

REFERENCES

1 Aldrich, Robert A.: Flow of Water in Pipes with Multiple Outlets, unpublished master's thesis, the State College of Washington, 1952.

2 Barton, James R.: A Study of Diverging Flow in Pipe Lines, unpublished master's thesis, University of Iowa, 1946.

3 Buhr, D. A.: A Study of Hydraulic Losses in Sprinkler Irrigation Couplers, unpublished master's thesis, Utah State Agricultural College, 1950.

4 Carstens, M. R.: The Hydraulics of Sprinkler Irrigation Systems, Washington State Institute of Technology, Bulletin No. 212, May, 1951.

5 Christiansen, J. E.: Hydraulics of Sprinkler Systems for Irrigation, Transactions, American Society of Civil Engineers, vol. 107, pp. 221-239, 1942.

6 Oakey, John A.: Hydraulic Losses in Short Tubes Determined by Experiment, *Engineering News Record*, vol. 110, June 1, 1933, pp. 717-718.

An Experimental Harvester for Castor Seed

By Milo F. Arms and Lloyd W. Hurlbut
ASSOC. MEMBER ASAE MEMBER ASAE

AS SOON as suitable varieties of castor seed were developed for the United States, the need for the development of a harvester was recognized. The need for a local source of castor oil was emphasized by government authorities near the beginning of World War II. The present world situation has re-emphasized the importance of locally produced castor oil and has increased the demand for research and development work on the castor seed plant as well as machinery for harvesting and processing the seed. There was little hope expressed for extensive commercial production of castor seed in the United States until the harvesting problem could be solved satisfactorily.

CROP CHARACTERISTICS

Present commercial castor varieties may be divided into three groups considering plant height. They are commonly referred to as the dwarf group, the intermediate group, or the tall group. The dwarf group is usually less than 4 ft tall with some branches located low on the stem. The racemes (clusters of seed capsules) are relatively small in size and distributed throughout the plant. The intermediate group is of medium height. A few varieties in this group have branches growing close to the ground. The low-branching varieties have racemes fairly evenly distributed throughout the plant. The high-branching varieties have racemes concentrated fairly well in the upper portion of the plant. The tall group are generally 6 ft or more in height, with some varieties low branching and others high branching. The high-branching varieties generally have fewer racemes than the shorter varieties but the racemes are quite large. They are located mainly in the upper portion of the plant. The stems and branches of all groups are quite sturdy during the growing season, but they become dry and brittle soon after being killed by frost, or by other means.

Near harvest time, the plants have racemes in all stages of development. Some racemes are in bloom while others contain mature capsules. Raceme development and maturity is ended by the first freeze in the fall (1)*. This characteristic variable in seed development complicates harvesting, shelling, and storage, except when the seed capsules are harvested after an extended period of drying subsequent to the time the plants were killed. An unfavorable shattering characteristic of the dry racemes makes an early harvest desirable. The importance of this latter characteristic may be reduced as agronomists breed varieties with better harvesting characteristics.

The cultural practices for castors are similar to those for corn or cotton. The corn planter with standard seed boxes may be used for planting the seed, if special seed plates are selected carefully to fit graded seed. Special seed boxes with inclined plates are also available. The seed is commonly planted in rows spaced 38 to 42 in apart. The plants are spaced from 18 to 30 in apart in the rows depending upon the soil and the moisture available (2). The rows can be cultivated with a conventional corn cultivator.

The yield of castor seed varies widely depending upon the variety, the length of growing season, the type of soil, and the available moisture. Under irrigation, yields of 2500-3000 lb per acre are reported in southern California (3, 5). At Lincoln, Neb., the average yield for dry-land castors was 1216 lb per acre in 1948 (7).

GENERAL REQUIREMENTS FOR A HARVESTER

Preliminary harvesting tests suggested the desirability of having the stalks remain standing in the field for subsequent harvest, in case a market develops for the plant fiber. This plan requires the use of a stripping device for removing the seed from the plant with only a minimum of plant fiber gathered along with the seed.

The present unfavorable shattering characteristics of the racemes at harvest time appears to justify the construction of a compartment for surrounding the plant prior to the stripping operation, according to Wiebel and Burlison (6). The dimensions of this compartment is governed by row spacing, size of plant, and the forward movement of seed capsules after they have been loosened from the plant. For high harvesting efficiency, it should enclose the plant as completely as possible and at the same time subject the approaching plants to a minimum amount of disturbance and shock. This same consideration applies to the plants in the adjacent row.

The seed strippers apparently must contact the plant near the ground where the stem is anchored firmly and where there is a minimum number of branches. They must be sufficiently aggressive to remove the seed capsules, but not remove an excessive amount of plant fiber. These conditions indicate that the stripper elements must slope upward toward the rear of the compartment and be of sufficient length to reach from the base to near the top of the standing plants. A variable-speed drive to the strippers would make it possible to adjust the stripping action to meet existing harvesting conditions. Action of the strippers may need to be supplemented, under some conditions, by a rubbing effect which will loosen capsules contained on sections of racemes stripped from the plant.

A means must be provided for transporting the capsules from the stripping compartment to the separating and cleaning unit. The conveying device should be positive in action yet it should not damage the seed coat (4).

A separating and cleaning unit should be provided to separate the broken plant fiber from the seed capsules. This device must separate seed capsules from plant fiber having almost the same density as the seed. It seems worthy to note that the greatest difference between the capsules and plant fiber appears to be in their shape.

Other important parts of a castor-seed harvester include transport wheels, power-take-off drive, elevator and collector bin. Condition of both the plant and the seed at harvest time in Nebraska seems to justify separate harvesting and hulling operations at the present time.

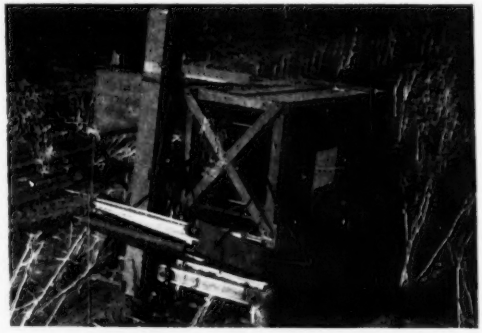


Fig. 1. Rear view of experimental castor seed harvester showing separating and cleaning unit.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Kansas City, Mo., June, 1952, as a contribution of the Power and Machinery Division. Published with the approval of the director as Paper No. 587, Journal Series, Nebraska Agricultural Experiment Station.

The authors — MILO F. ARMS and LLOYD W. HURLBUT — are, respectively, instructor in agricultural engineering and head, agricultural engineering department, University of Nebraska.

*Numbers in parentheses refer to the appended references.

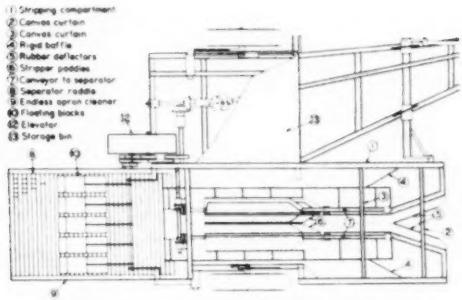


Fig. 2. Top view of experimental castor seed harvester.

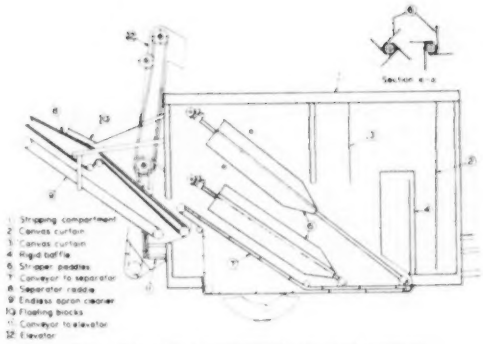


Fig. 3. Side view of experimental castor seed harvester.

EXPERIMENTAL CASTOR SEED HARVESTER

The Nebraska experimental harvester† is a right-hand, single-row, pull-type machine driven by a power take-off. It has two transport wheels, the right-hand wheel being recessed into the stripping compartment (Fig. 1). The right side of the machine presents a relatively flat smooth surface to the adjacent row.

The stripping compartment (Fig. 2-1) is 40 in wide, 64 in high, and 96 in long. It has a bottom slot 6 in wide with the front portion expanded to a width of 18 in. This slot is normally closed with overlapping strips of pliable rubber. Other features which make the compartment as seedtight as possible include: *(a)* two strips of light-weight canvas suspended from the top and attached to the sides of the compartment 8 in from the frontal opening (Fig. 2-2); *(b)* side baffles mounted about 16 in back of the frontal opening (Fig. 2-4), and *(c)* a short canvas curtain suspended from the top about 27 in to the rear of the frontal opening (Fig. 3-3).

Four stripper elements, located inside of the main compartment parallel to the bottom passageway for the plants (Fig. 2-6), serve to strip the seed from the plants. Each element consists of a main shaft carrying four strips of 5-in rubber belting tapered at the lower end so that the base of the plant will move into the stripping unit easily. The stripper elements slope upward toward the rear of the machine at an angle of about 40 deg (Fig. 3-6).

The stripper elements are mounted in two pairs with one pair located about 18 in above the other. They all turn so that the stripping action is upward on the plant. The upper and lower pairs of elements are located so that their respective strips of belting overlap approximately one inch and are timed about 45 deg apart (Fig. 3, section a-a). A variable-speed drive provides a means for determining that the strippers must turn about 380 rpm when the machine is traveling about 2 mph.

Two conveyers, one on each side of the bottom slot, serve to transport the stripped material to the separating unit (Fig. 3-7). Each conveyor consists of two steel chains connected by rubber-faced dragflights. These chains are recessed and the dragflight are fitted close to the bottom of the conveyor in order to prevent damage to any capsules which are segmented.

A raddle constructed of small slats spaced 1.5 in and interlaced with narrow strips of rubberized canvas of the same spacing serves to elevate the seed and fiber. It also serves to separate the large pieces of plant fiber from the capsules (Fig. 3-8). A flat surface under the forepart of the raddle causes the seed capsules and fiber to be carried about one-half its length. Small triangular plates fixed in line with the center of the chains and located in the center of the separating section of the raddle causes this section of the raddle to vibrate and release entrained capsules. The return part of the raddle contains a sharp upward bend immediately below the upper end of the elevating section. This bend is designed to prevent capsules from bouncing along the normal downward slope of the return section of the raddle.

Rubber-faced blocks are located so that they ride on the separating section of the raddle and provide a supplemental "threshing" action to break up whole racemes or sections of racemes stripped from the plant (Fig. 3-10).

An endless inclined apron serves to remove small irregular sections of plant fiber from the capsules and shelled seed. The slope of the inclined apron can be adjusted anywhere between 32 to 45 deg. The angular range and the speed of the apron (approximately 190 fpm) were established by laboratory experiments (Fig. 4).

Other fundamental parts of the harvester are a cross conveyor consisting of a 6-in belt located at the base of inclined apron, an elevator constructed of 6-in belting equipped with flexible flights, and a 16-bu overhead collector-bin for the harvested seed (Fig. 1).

†Funds for developing the Nebraska harvester were provided by Nathan Gold of Lincoln, Neb., and the Baker Castor Oil Co.

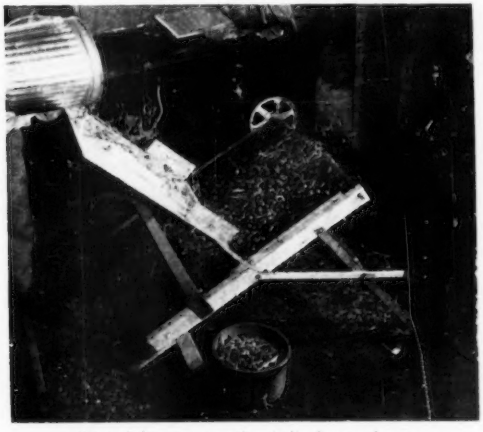


Fig. 4. Laboratory tests of an inclined-apron cleaner.

BELLE CITY EXPERIMENTAL HARVESTER

In 1948 the Belle City Mfg. Co. started construction of five experimental machines patterned fairly closely after the Nebraska harvester on a special order issued by The Baker Castor Oil Company. By 1949, twelve of the Belle City machines were available for use. One of the machines was given a preliminary field test at the University of Nebraska in 1948. A second machine was given a fairly thorough field test the following year.

The preliminary test, in 1948, showed that exterior ribs, exposed shaft ends, and exposed pulley caused appreciable shattering in the adjacent row. These parts were covered with a smooth supplementary surface and improved performance

resulted (Fig 5). This machine differed from the Nebraska machine in that a horizontal auger was used to convey the capsules to a chain-type elevator equipped with rubber-faced dragflights. The auger and chain elevator worked satisfactorily.

FIELD TEST PROCEDURE

Two varieties, Connor and 108-3, were used in harvesting experiments. The Connor variety is tall, high branching, and has most of its racemes located near the top of the plant. The 108-3 variety is of medium height, low branching, and has racemes scattered throughout the plant.

The test plots for each variety were subdivided into pairs of rows so that alternate rows were harvested by hand and by machine. The hand harvest was done first to eliminate all machine losses. Each handpicked row was later machine harvested in order to get the machine effect in the adjacent row.

Representative samples of both hand-harvested and machine harvested seed were subsequently shelled by hand in order to determine the percentage of clean seed. The machine-harvested samples were inspected carefully and a record was made on the amount of seed damaged by the harvester.

DISCUSSION OF TEST RESULTS

Wide variations in plant conditions were observed during the harvest seasons of 1947, 1948, and 1949, at Lincoln. These variations resulted from differences in the weather prior to harvest time. In 1947, the plants were not completely defoliated by the first frost. The leaves became dry and hung loosely on the plants for a period of several weeks. In 1949 an early light frost killed many of the leaves and the branch tips of plants growing in the low areas of the field. These plants were almost completely defoliated, but later they began to form new leaves. All of the plants were completely killed by a frost two weeks later. Subsequent to the killing frost, high winds caused considerable lodging in the low areas of the field and broke over the small peduncle carrying the racemes. At the time of harvest, the racemes on many of the plants in the low area were hanging down and they were not firmly attached to the branches. The plants on the higher areas were not materially affected by the early light frost and the wind did only minor damage in that area. The upland plants were standing erect with the racemes firmly attached to the branches at harvest time.

During the early stages of development of the Nebraska harvester, in 1947 and 1948, experimental field trials served only for observations. Field tests to determine harvesting efficiency of the two experimental harvesters were conducted first in 1949.

Data recorded in tests with the two experimental mechanical harvesters (Fig. 6), show that minor modifications and improved adjustment reduced the harvesting losses, even though the time delay involved in making changes may have been somewhat of a counteracting factor. It should be added

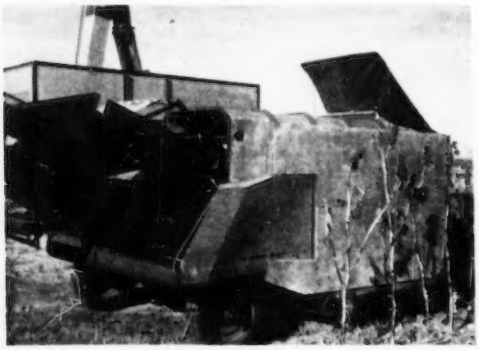


Fig 5. The Belle City castor seed harvester equipped with an extension above the frontal opening. This special device was used in a field where some of the plants were 9 ft tall. The right-hand side of the machine was equipped with a relatively smooth surface.

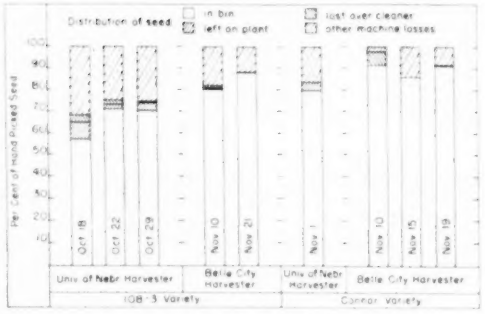


Fig. 6. Summary of castor seed harvester tests.

that the original Nebraska harvester had been modified several times previously and was nearing the end of its useful life.

The better harvesting efficiency shown for the Nebraska harvester (Fig. 6) on October 22, compared to October 18, is due mainly to improved gathering points, higher speed of the strippers, rubbing blocks above the raddle, and greater slope for the endless cleaning apron. Tests on October 22 and 29 indicate that a delay of one week did not materially affect the harvesting efficiency. A test on October 29 in the 108-3 variety and another test on November 1 in the Connor variety indicate that the shape and size of the plant materially influenced the efficiency of the harvester. The harvesting efficiency was highest in the less bushy Connor variety even though the extremely tall plants extended above the top of the stripping compartment. Many of the plants were 9 ft tall.

Tests made with the Belle City experimental harvester on November 21 in the 108-3 variety show a higher efficiency than those tests made on November 10. A comparison of these tests indicate the effect of adding a smooth shield over protruding parts that caused some shattering in the adjacent row. The highest harvesting efficiency, obtained with the 108-3 variety, was about 88 per cent.

Tests in the Connor variety indicate a maximum possible machine-harvesting efficiency of about 97 per cent. A comparison of the data recorded on November 10 and subsequent dates indicates that the lack of proper adjustment of the cleaning unit in the November 10 test resulted in an excessive loss over the cleaner. November 10 was 17 days after the killing frost. By November 15, the Connor variety had dried somewhat and the effects of protruding parts on shattering in the adjacent row became noticeable. A field test four days later, on November 19, showed that a smooth shield over the protruding parts improved the harvesting efficiency substantially. This test also indicated that a carefully adjusted harvester of the stripper type in the slender, erect Connor variety should work throughout the normal harvest season at about 90 per cent harvesting efficiency.

CONCLUSIONS

Tests with an experimental stripper-type harvester indicate that castor seeds can be harvested from selected existing varieties with a harvesting efficiency of 90 to 97 per cent. Harvesting efficiency is influenced by weather conditions, time of harvest, type of plants, erectness of plants, harvester adjustment, rate of forward travel, and ability of the operator to follow the row.

The harvesting efficiency will undoubtedly improve when better varieties of castors are developed.

REFERENCES

1 Domingo, W. E. and Crooks, D. M.: Investigations with the Castor Bean Plant. J. A. S. A., pp. 750-762, vol. 37, no. 9, Sept., 1945.

2 ———: Investigations with the Castor Bean Plant. J. A. S. A., pp. 812-820, vol. 37, no. 10, Oct., 1945.

3 Domingo, W. E.: Castor Beans, a Truly Chemurgic Crop. Chemurgic Digest, vol. X, no. 3, March, 1951.

4 Jamison, G. S.: Vegetable Fats and Oils, second edition, Reinhold, 1945, p. 17.

(Continued on page 790)

Drainage in the Red River Valley of North Dakota

By C. J. Francis
MEMBER ASAE

THE Red River of the North is the only river in the United States that empties into Hudson Bay. It rises in Lake Traverse, which is on the boundary between South Dakota and Minnesota, and flows due north forming the boundary between North Dakota and Minnesota, crossing into Canada near Pembina, N. D.

Effect of Climate on Drainage. The long-time average annual yearly rainfall in the valley is approximately 21 in. From year to year, the total annual fluctuates widely from the average. This condition has made it difficult to establish a long-time drainage program. As would be expected, drainage activity largely coincides with periods of high rainfall. During the period 1861 to 1877, when settlement started, the average annual rainfall was 18.29 in. This was not sufficient to create a serious drainage problem. For the period 1878 to 1916, the average annual rainfall was 24.45 in, and the records show that there were 21 years in which the rainfall exceeded 24 in and three years in which the rainfall was in excess of 30 in. Serious crop damage occurred over the area and it was during this period that action was initiated to develop and carry out a drainage program. During this era of high rainfall a request was made to the U.S. Department of Agriculture for technical assistance, which resulted in a study conducted by J. T. Stewart, and, as a result of his recommendations, many large drainage systems were built. From 1916 to 1940 the average annual rainfall was only 17.80 in and the demand for drainage practically ceased. A closer examination of the records for this period shows that from 1929 to 1940 the annual rainfall was only 15.46 in. The low was recorded in 1936 when there was only 8.87 in of precipitation. The drought of the thirties was accompanied by severe wind erosion which partially filled many of the channels. As there was not enough runoff to create appreciable flow during the drought, vegetation and brush became established to further obstruct the channels and improve the conditions favorable to water and wind-borne silt deposition. As the drains generally served no useful purpose during this period, no maintenance was done. In fact, many people who came to the valley during and immediately prior to the drought were of the opinion that drainage was a waste of money and not essential to the economy of the area.

Subsequent to 1940 rainfall began to increase. It reached a high of 30.38 in in 1945. Immediately the valley was transformed from a dry-land area to an extremely wet area. Crop damage was severe. In 1943, it was estimated that in six counties 634,000 acres of land were totally or partially out of production, entailing a crop loss of $10,852,000. In 1944, a similar estimate including 10 counties showed 1,026,000 acres affected by lack of drainage, representing a total loss of $13,565,000, or $13.22 per acre. The demand for high agricultural production due to the impact of World War II, coupled with high prices, made it essential that steps be taken to provide adequate drainage for the area.

SCS Drainage Program. Requests for assistance were made by individual groups, municipalities, counties and legislators, which resulted in the Department of Agriculture authorizing the Soil Conservation Service to organize their operations to provide technical assistance in planning and supervising the construction of drainage systems. The program covered the rehabilitation of existing drains and the construction of new drains. The first problem was to provide an adequate system of outlets for the area; so, for the first few years, efforts were largely concentrated on the building of main drains. One of the problems involved in getting the work done was in finding contractors who would do the work at reasonable prices. In order to help alleviate this situation, the federal government allocated a sum of money to the Soil Conservation Service for the purchase of equipment. The Soil Conservation Service loaned the equipment to soil conservation district boards of supervisors who acted as contractors, doing work by the hour or by the job as the occasion required. The government only purchased a limited amount of equipment so there was plenty of work for all private contractors that were available. The government-owned equipment was generally used on small group and individual jobs, and the bigger jobs were advertised and given to contractors.

As soil conservation districts were essential to provide a vehicle for getting the construction and drainage job done, the people responded and immediately formed districts in all the counties in which drainage was a problem.

North Dakota recognized the need for the immediate construction of drainage works to permit the land in the valley to approach its production potential. As an aid in speeding up construction, the state legislature appropriated a total of $730,000 over a 10-year period, to be made available to legal drainage districts for rehabilitation of old drains and construction of new drains on a 60-40 basis. On approval of plans by the chief engineer of the state water conservation commission, the state allocates 40 per cent of the cost of the project to the drainage district. This financial aid proved a great impetus in getting the job done.

Many non-legal group drains were built under the program. These drains were eligible for ACP payments under what is known as a pooling agreement. Under this agreement, the federal contribution is about the same as is provided by the state for legal drains. Legal drains are not eligible for ACP payments. All individual farm drainage operations were covered by the ACP program.

Revision of Drainage Laws. Drainage laws existing at the time the drainage program was initiated were not designed to facilitate rehabilitation of old drains. The laws in force limited the expenditure for cleanout operations on any one drain to $100, except under conditions where 60 per cent of the interested individuals petitioned the county to do the job. Such a law was a major deterrent to sound maintenance operations. It is a difficult and time-consuming problem to secure the signature of 60 per cent of the freeholders, and for practical purposes an expenditure of not to exceed $100 is inconsequential insofar as rehabilitation of a drainage system is concerned.

At the request of people in the area needing drainage, this law was amended to make it mandatory for the county commissioners to keep the drains open and in a good state of repair. The cost of the maintenance is levied and collected in the same manner as required for the original construction of the drain. The law provides that the levy for any one year shall not exceed a maximum of 50 cents an acre on the lands in the district. The county commissioners may accumulate a fund for this purpose but the fund shall not exceed the maximum levy allowable for any one year. The county board is required to let jobs to the lowest responsible bidder. To enable use of equipment furnished by the government, laws were revised to the extent to permit the county commissioners to enter into a contract with the soil conservation district supervisors to do the work if, in their opinion, the work could be done more cheaply with equipment loaned them by the Soil Conservation Service. The Act further provides that under conditions where the levy and accumulated funds are not sufficient to finance the work proposed, the county commissioners, on a petition of property owners representing 10 per cent of the cost of the work, are required to hold a hearing of all interested parties. If owners of 51 per cent of the property liable for the cost agree to the project, the board is authorized to proceed. This and other changes in the existing laws greatly facilitated the carrying out of the program.

Technical Standards. The report made by J. T. Stewart of

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Kansas City, Mo., June, 1952, as a contribution of the Soil and Water Division.

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the U.S. Department of Agriculture in 1907 proved to be extremely valuable in formulating plans for drainage works. Checks run in the field at selected points showed that the topography could be used without question, so we were relieved of the necessity of taking topography over wide areas for the purpose of delineating drainage areas and land slopes. The report also proposed a complete plan of main and lateral ditch systems in the area, which was an invaluable guide in planning drainage systems. Naturally, we were not always able to follow specifically all the recommendations made by Mr. Stewart, due to local conditions. In general, however, the pattern of drainage we developed fits the Stewart plan closely. As a matter of interest his estimate of cost for complete drainage of the area, including right-of-way and bridges and allowing 11c for the cost of excavation, was slightly in excess of $2 per acre, based on the area benefited. The present cost index in the area is about 2.0. So, based on his analysis, the cost of draining the area is $4 per acre. While we have not made an analysis of the total per-acre cost of drainage, based on representative jobs, this figure approximates present-day costs of providing outlet drainage.

Runoff Coefficient. There was no data available on drainage coefficients to be used in the design of drainage systems, except that proposed by Stewart in 1907. The Soil Conservation Service had no background of drainage experience in the area, but an analysis of a great number of old drains built in accordance with Stewart's recommendations indicated that adequate drainage was being provided. The matter was taken up with Mr. Sutton, head of the drainage section (SCS) in the Washington Office, and a decision was reached to use the runoff coefficient curve proposed by Stewart. This curve gives a coefficient of runoff of $\frac{1}{4}$ in in 24 hr for 25 sq mi of drainage area, decreasing with an increase in drainage area and increasing with a decrease in drainage area. The chief engineer of the state of North Dakota required that all projects approved for the state grant of 40 per cent of the cost be designed in accordance with the Stewart curve. Based on the experience obtained since 1944, when the SCS program was initiated, it is our opinion that the Stewart curve gives adequate drainage for the area even though it gives a coefficient somewhat lower than those recommended for similar areas to the east in the higher rainfall belt. We had an excellent opportunity to study the effectiveness of drains during the 1948 flood, which reached a 51-year peak. The flood was caused by a heavy snow melt. Most of the drainage systems were overtaxed largely due to the inability of the major tributary streams to carry the runoff that occurred. The channel capacity of the Red River is insufficient to carry runoff created by snow melt, so the whole valley was inundated. Due to the overflow from tributary streams, the ditches were operating far above design flow, and as a consequence large areas adjacent to the ditch systems were inundated. However, as soon as the overflow from main streams stopped, the ditches rapidly drained the excess water and made it possible to put the land in crops as soon as the soil dried sufficiently.

Those ditch systems that were inspected all provided very satisfactory drainage. Considering that the total flow was greatly in excess of design flow, it appears reasonable to conclude that the drainage coefficient used in design is ample.

Ditch Cross Section. Standards for main drains and laterals call for minimum depth of flow at design stage of 4.0 ft, with the exception that the depth may be reduced to 3.0 ft at the upper end when such a depth assures adequate drainage for the adjacent land.

The bottom width was set at a minimum of 4.0 ft.

The side slopes were specified to be not steeper than 2:1. In several of the counties, all ditches are built on 3:1 slopes in order to reduce maintenance. The trend to flatter slopes in these counties was created by experience gained on several drains that were built to these slopes on our recommendations. We have experienced difficulty in maintaining side slopes on ditches constructed in sandy soils. Irrespective of the slopes used, the cross-section of most of the ditches that have been built in sand has decreased in depth and increased in width to the extent that ultimately a broad shallow channel exists that is of little value to drainage of adjoining lands. Continued maintenance does not appear to alleviate the situation. It is our opinion that ditches in sandy soils will require excessively high maintenance costs to keep them in operative condition. Under conditions where it is possible to establish vegetation, the cross section may be partially maintained for reasonable periods of time.

Velocities. The velocities used in design are in conformance with the table of permissible canal velocities after aging, as recommended in 1926 by the American Society of Civil Engineers. It is recognized that the intermittent flow encountered in drains will permit somewhat higher velocities than given in the table when conditions are favorable to the formation of vegetation.

Roughness Coefficient. We use an n of 0.030 to 0.035 for bottom widths over 6 ft, and 0.04 for widths less than 6 ft, considering a depth of at least 4.0 ft. An n of 0.040 is used for depths less than 4.0 ft.

Disposal of Waste. Every effort is made to level spoil banks. This condition has been met in practically all instances except in connection with cleanout jobs where right-of-way is not sufficient and additional right-of-way cannot be obtained.

Field Inlets. Field inlets are to be in accordance with the standard plan shown in the SCS Region 5 engineering handbook. Vegetated flumes or standard pipe structures are approved. The location and installation of inlets is provided for at the time of construction. Vegetated flumes have seeded naturally as the banks of the drain are well vegetated the second year after construction.

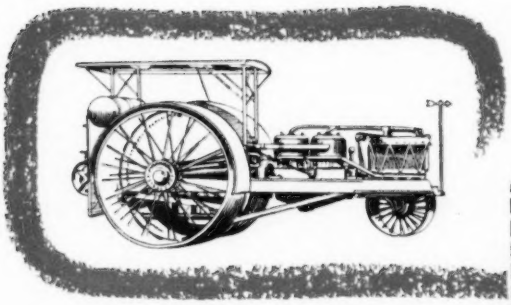
Bridges and Culverts. Bridges are preferred to culverts. When culverts are used, the cross-sectional area shall not be less than one-half of the cross-sectional area below the hydraulic gradient of the ditch at that point, or the maximum head on the culvert shall not be more than 0.2 ft, based on the design flow.

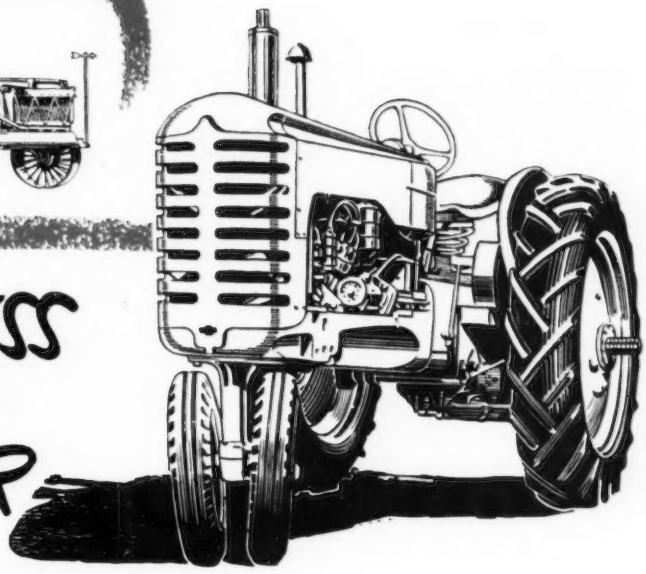
These standards were developed cooperatively with Region 3 which operates on the Minnesota side of the river, to assure a uniform approach to the design of drainage ditches in the Red River Valley.

Grade at Outlet. As the Red River is deeply entrenched in the valley floor, the tributary coulees and streams which serve as outlets for drainage systems create an outlet problem. In many cases it has been necessary to increase the grade at the lower end of main drains to permit the grade line of the ditch to meet that of the natural outlet channel. In many instances the increase in grade creates velocities far in excess of the nonerosive velocity. However, the main stream is usually at flood stage at the time the drain is operating so the steep gradient is neutralized to some extent. We have found that it is the best practice to provide a gradual steep slope at the end of a drain rather than maintain a flat grade and end in an abrupt overfall at the outlet. Overfalls will cut back and eventually stabilize on a steep grade, but much less erosion is induced by providing for a gradual transition from the grade of the ditch to that of the outlet. Observations made on a large number of old drains that have been functioning for 30 to 40 years show that satisfactory outlets can be obtained on steep grades. Little use has been made of structures for outlet control because of their cost. In most instances, a series of structures would be required because the grade in most waterways could not be considered stable enough to insure maintenance of one structure at the point where the ditch enters.

Special Conditions. One factor that affects the operation of ditches in this area is that snow melt is responsible for creating major flood conditions. The channels of the Red River and tributary streams are not adequate to handle the flow created by melt of a heavy pack of snow; consequently, the lower bench of the valley is often completely inundated. This same condition is created to a lesser degree by the drains themselves.

The ditches in this area fill with snow and as the snow is compacted and of greater depth than on the fields, it remains in the ditch after initial runoff begins. Thus, for a period after runoff starts, the ditch capacity is zero and water backs up in fields and inundates large areas. As soon as a channel is cut in the snow-filled ditch and *(Continued on page 790)*





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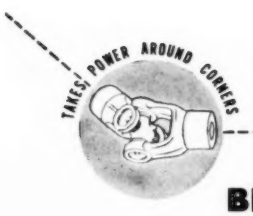

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Drainage

(Continued from page 788)

flow starts, the ditch is quickly cleared and operates at capacity. Some farmers have devised equipment for making the small furrow required to provide the initial channel. Some further study is required to determine if it is practical to solve this problem. Due to the fact that the flooding occurs at the time the ground is frozen, there is no crop damage and the planting time for crops is not delayed.

Observations in those areas where fields were inundated due to a temporary increase in the contributing drainage area, or because the ditch capacity was reduced due to snow drifts, showed some erosion took place in fields adjacent to the ditch and at inlets to the ditch. The erosion was created when the flow line of the ditch dropped below the adjoining land level, leaving an overfall that created erosive velocities. Flow occurred for a considerable period under such conditions due to the extensive area that was inundated. The outlets provided were not large enough to handle such large volumes of water, and, due to the depth over the drainage area, water entered the ditch at locations not provided for in the design. Most of the erosion occurred in the fields — the damage to the ditch banks was not at all serious. The erosion, however, contributed silt which was deposited in the ditch. As the ditches are new, the n is much lower than that used in the design; consequently, the velocity of flow was greater than originally figured. Higher velocities caused much of the silt to be carried through the ditches and deposited in major drainageways. It is difficult to obviate this condition entirely; however, maintenance of a strip of sod at least a rod wide adjacent to the ditch, in addition to provision of an adequate number of outlets, would be helpful.

Some sloughing of ditch banks was observed in certain isolated sections of ditch systems. The sloughing, for some reason, was largely confined to the east bank of north and south ditches, and to the south bank of east and west ditches. The general winter wind direction in this area is from north to south and west to east; thus the snow would be deepest and more compact adjacent to the north and west banks. It may be deduced that the first flow in the ditch is directed against the east and south banks because of the above-mentioned conditions. As this bank is exposed first, it thaws more rapidly due to the action of the sun and the water in the ditch. This may account for the sloughing that occurs.

Farm Drainage. Up to this point, this paper has centered on the planning and construction of main drains. There were good reasons for such an approach. In the first place, due to the general lack of drainage work in the valley, it was necessary to provide a system of main drains to serve as outlets for the much needed farm or field drainage. Also, landowners were not familiar with the problems involved in drainage and generally held the opinion that all that was needed was a main drainage system. We carried out an extensive demonstration program of establishing farm drainage systems and gradually sold the idea that farm drainage was a necessary part of any over-all drainage program. The first few years the program was in operation, main drainage works far exceeded farm drainage operations. Now that the program is better understood, however, farm drainage operations exceed main drain construction. In a few more years we will have a large part of farm drainage work completed in areas where outlets are available. There is no need here to go into detail regarding the technical aspects of farm drainages. We have employed the random and parallel ditch system described in the paper, entitled "Surface Drainage of Tight Soils," by K. H. Beauchamp, (AGRICULTURAL ENGINEERING for April, 1952, page 208). Originally, we recommended V-type ditches having flat side slopes. Due to rapid loss of effective depth of this type of ditch and the difficulty of construction with much of the equipment available in the region, we turned to a trapezoidal section which is now used to the practical exclusion of any other type.

SUMMARY OF SCS DRAINAGE OPERATIONS IN COUNTIES IN THE RED RIVER VALLEY OF NORTH DAKOTA

(For the Years 1944 to 1951)

County	New legal drains, cu yd	Group drains, cu yd	Clean old drains, cu yd	Main drains, miles	Farm drains, cu yd	Farm drains, miles	Total Excavation, cu yd	Total length, miles
Pembina	563,995	122,344	869,403	80.0	373,515	71.3	1,929,258	151.3
Walsh	493,700	284,565	61,000	62.5	806,170	221.7	1,645,435	284.2
Grand Forks	84,942	406,021	132,693	48.9	706,731	126.7	1,330,347	175.6
Traill	77,974	662,835	47,901	114.2	1,233,692	487.9	2,042,402	602.1
Cass	32,522	1,793,117	1,336,690	377.2	1,525,884	524.5	4,688,213	901.7
Richland	1,100,432	720,466	181,019	229.7	1,209,954	400.0	3,211,871	629.7
	2,373,565	3,989,348	2,628,666	912.5	5,855,946	1,832.1	14,847,526	2,744.6

COUNTIES BORDERING RED RIVER VALLEY

Main and group drains		Farm drains		Total	
cu yd	miles	cu yd	miles	cu yd	miles
491,329	97.3	2,244,477	608.2	2,735,806	705.5

Progress of the Work. In the initial stages of the program, we built up a big backlog of plans for main drainage systems. We found that from 1 to 3 years is generally required for the people to perfect an organization, straighten out legal matters, and reach a decision to carry out the construction. We used every possible means of screening applications before making the surveys required to prepare a construction plan in order to insure a balance between plans and construction. Construction lagged considerably behind plans during the first few years. However, we found the fatality rate for plans over a long-time period to be low. Practically all of the plans we have prepared have eventually been approved for construction.

During the 8-year period the Soil Conservation Service has planned and supervised the construction of drainage works having a total ditch length of approximately 3,400 miles involving 17,500,000 cu yd of excavation. A detailed summary of the program is shown in the accompanying tabulated summary.

We have not made an inventory of all the drainage systems in the valley but, based on our information, the drainage program outlined in Stewart's report for the Red River Valley is approximately 35 per cent complete. As would be expected, the ratio of drainage works constructed to works proposed for complete protection varies from north to south. The ratio is highest in the southern counties where the land is more intensively cropped primarily because of the longer growing season. The rate at which the remainder of the job is done will depend largely on climatic and economic conditions. A continuation of the present wet cycle will result in continued drainage operations at a high level.

We fully appreciate that another drought will slow up drainage work. We are, however, confident that maintenance will be continued to the extent that the drains will remain operative through a protracted drought period due to the intensive educational program that has been carried. Farmers have come to realize that farm drainage is an essential part of any drainage job; thus they will take a more active interest in seeing that main outlet systems are kept in good operating condition.

Harvester for Castor Seed

(Continued from page 786)

5. Knowles, P. F. Castor Bean Production in California. University of California, Davis.

6. Weibel, R. O. and Burlison, W. L. A Review of the Experimental Work on Castor Beans in the United States. Chemurgic Papers, 1946, series 3, no. 461, p. 6.

7. Woodward, R. E. and Hoffman, A. Industrial Survey of Castors, Chemurgy Project, University of Nebraska, Jan., 1949, p. 7.

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The Value of Replications in Research

By Eugene G. McKibben and Milton O. Berry
FELLOW ASAE ASSOC. MEMBER ASAE

THE terms fundamental and applied research have been the subject of much debate for many years. A great deal has been said about the relative values of and the differences between these two kinds of research. A simple definition for fundamental research is a search for new knowledge, for its own sake without concern as to whether it will ever be applied, while applied research may be defined as a search for new knowledge to be immediately applied to the solution of a specific problem.

Very little agricultural-engineering research is of the strictly fundamental type because almost always the agricultural-engineering research worker is seeking the answer to one or more specific problems. There is, however, no reason why the worker in the field of applied research should not seek as much additional new knowledge as is possible without seriously handicapping his search for specific answers.

In fact, it is the author's opinion that much of the talk about so-called fundamental and applied research is beside the point. Most research carried on by modern scientists is a combination of the fundamental and applied. The important question is not whether a particular research project is fundamental or applied but whether it is as effective as possible. The test is in how it answers the following questions:

1 Is maximum use being made of the data from past investigations? Has there been an adequate search for such data?

2 Has proper consideration been given to experimental design and the effective use of statistical methods?

3 Is every practical means being used to control variables?

4 Are adequate records being kept of the experimental conditions and results? All unusual phenomena should be noted even though at the time they may not seem to be pertinent.

5 Are the findings being compared with and checked against those of similar research by other agencies?

6 Are the data obtained being related and analyzed so as to give the maximum amount of useful information, particularly information as to general principles?

7 In the case of public research agencies are findings being promptly and effectively published?

Perhaps the most important question which can be asked about any research project is, are the alleged findings real, are they true? If not, the research is worthless; if so, such findings may be invaluable. No one can be certain when, where or how such new knowledge may be useful.

One of the most common faults of agricultural engineering research in the past has been the failure to give adequate consideration to statistical methods. There are some explanations of this fault but no satisfactory excuse. In many earlier engineering studies it has been possible to control variables well enough so that the variability of the data obtained has been less than the differences in which the investigator was interested. Under such conditions statistical methods are not needed. The agricultural engineering research worker, however, is often working on projects where the soil or some biological phenomenon is one of the variables. Under such conditions some measure of the variability of the resulting data must be obtained. This requires at least three replications and in most cases more are needed to permit a satisfactory determination of reliability.

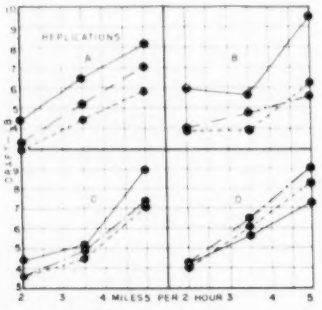
It is, however, a common observation that in planning research projects, agricultural engineers, including myself, tend to include too many treatments and not enough replications. We frequently try to justify this tendency by the great importance of each of the proposed treatments and limited facilities, funds or personnel. However, unless variables can be very completely controlled, there is no substitute for an adequate number of replications.

The disk plow draft data for three disks at three speeds shown in Fig. 1 to 4 illustrate this point. In Fig. 1 each replication is plotted separately. Replication A is the only one which, if taken by itself, appears like a satisfactory set of data. However, the curves for this replication have a slight downward concavity while the results of many carefully conducted tests of tillage implements, as well as the other replications, show the opposite direction of curvature.

(Continued on page 798)

Abridged paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Orono, Me., August, 1952.

The authors—EUGENE G. MCKIBBEN and MILTON O. BERRY—are, respectively, director of agricultural engineering research and associate agricultural engineer, Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S. Department of Agriculture.



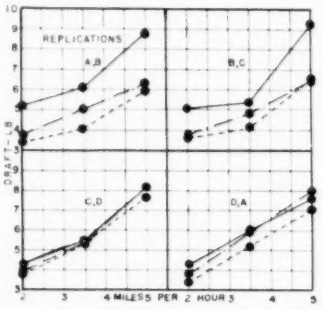
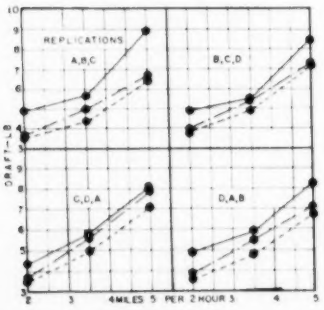


Fig. 1 (*Left*) Draft in pounds per square inch of a cross section of furrow slice for three disks at three speeds. Replications A, B, C, and D each plotted separately • Fig. 2 (*Right*) The data of Fig. 1 plotted as means of duplicate (two) replications



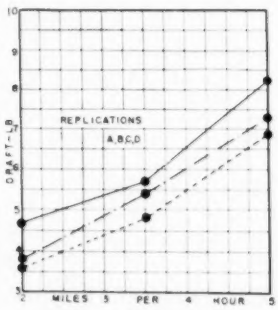


Fig. 3 (*Left*) The data of Fig. 1 plotted as means of three replications • Fig. 4 (*Right*) The data of Fig. 1 plotted as means of the four replications

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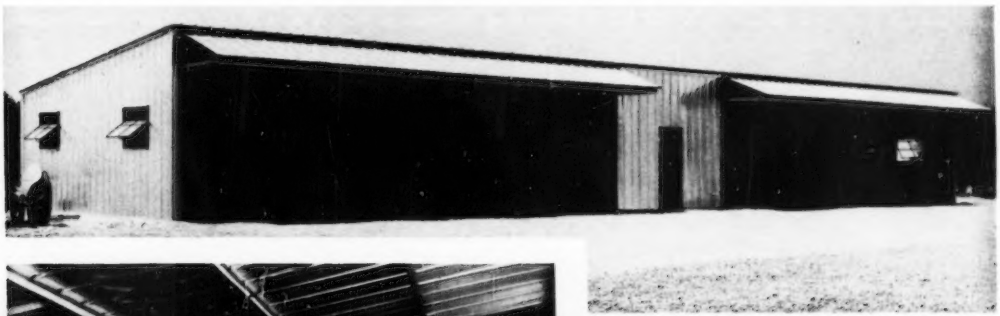

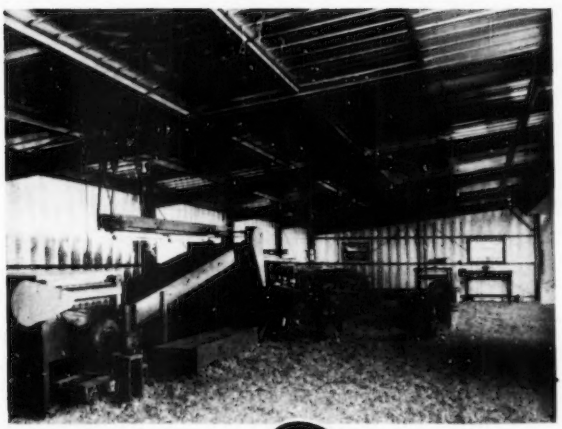

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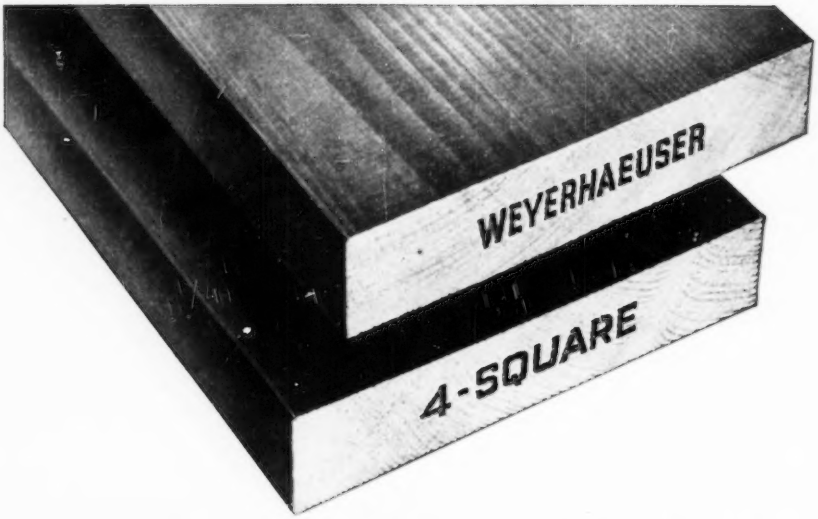

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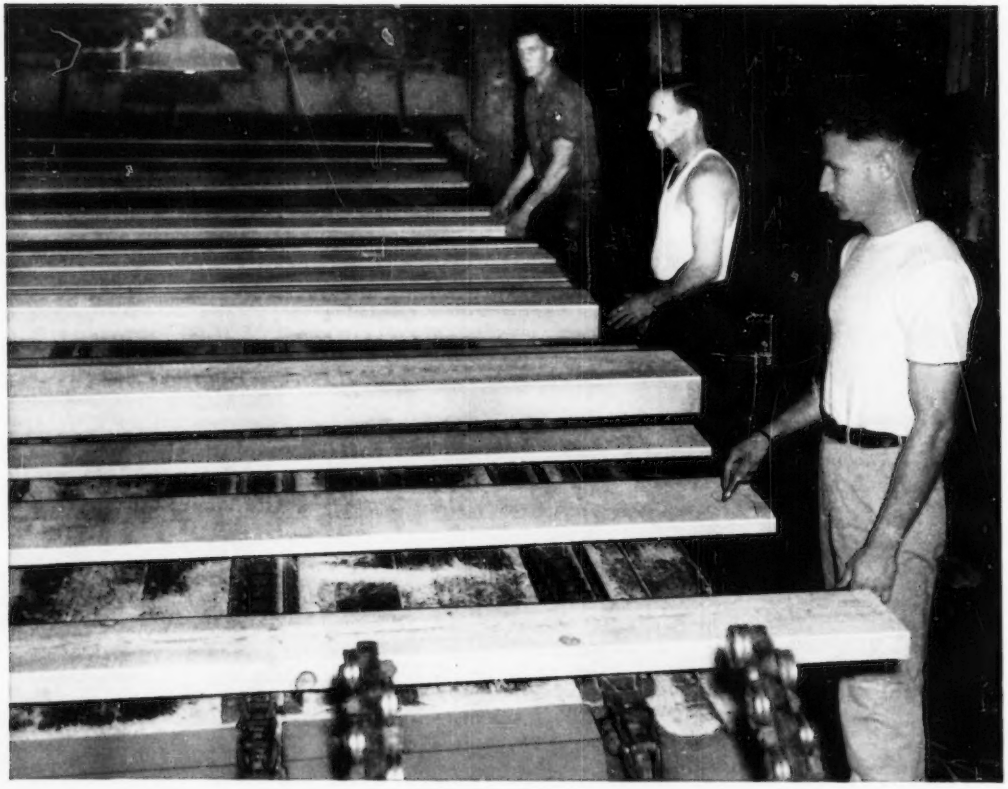

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Factors in the Improvement of Pastures

By Edward A. Silver
MEMBER ASAE

GRASSLAND farming, as we know it today, has expanded to where it is now considered one of the major systems in profitable agriculture. Like any other farm cropping pattern, problems have grown up with it. Methods for handling and storing grass silage and dry forage have been matured to a point of reasonable efficiency and practicality. The other phases — seeding, fertilization, soil processing, and pasture development of meadow crops — have been left for later exploration.

The relationship between soil, seed, and nutrients is complex, and their true relative importance to one another must be recognized by the engineer. Soil must be processed to optimum environmental conditions for germination of the seed and emergence of the seedling. Nutrients must be in position and balance to nourish the seedling throughout the early stages of growth.

Pasture Maintenance. Pasture maintenance involves the promotion and maintenance of an already established pasture with a healthy growth of plants through proper management of grazing practices, fertilization, liming, and other required soil and grass treatments.

Maintaining the proper nutrient balance, liming and grazing management are probably the three most important steps toward the maintenance of a good pasture.

Such disturbing factors as low water intake and hard soil formation persist in some areas. Unfortunately, if these conditions exist, their greatest impact will come during dry periods. At this time all rainfall should have ready access to the root zone. In order to accelerate water movement into the soil, several machines have been developed to form vertical channels extending from the surface to depths of from 5 to 12 in or more. These channels may be in the form of round holes or vertical slits. Evaporation, the counteracting force on gravitational water, must be taken into consideration in an operation of this kind.

Maintenance of a vigorous plant growth, through the application of a liberal supply of plant nutrients, will probably do more than anything else to foster rapid intake of water because of the effect which the roots of the plants have on the improvement of soil structure. The value of good soil structure in pasture maintenance cannot be overestimated. This suggests that, from an engineering standpoint, improvement in the design and use of seeders and fertilizer distributors may make the greatest contribution to pasture maintenance.

Pasture Establishment. This involves the preparation and fitting of land to optimum standards of soil structure and tilth, and seeding of the land with the desired mixtures and species for complete establishment of a pasture crop.

Many factors are involved in securing a good stand of vigorous healthy plants. One is the establishment of a well-prepared seed and rootbed of desired depth. Prime consideration must be given to the preparation of a finely granulated zone of soil which will assure spherical contact of seed with soil crumb, for quick and effective germination.

The root bed need not be refined to the same degree as the seedbed. Roots of our present mixtures of legumes and grasses occupy practically the entire area of a full plow layer. It is imperative, therefore, that air, moisture, heat and nutrients are readily available within that area. A finely granulated root bed retards the movement of some of these elements. A coarsely granulated root bed containing large clods will retard the movement of capillary water, but will enhance the downward movement of gravitational water.

It has been suggested that probably more failures of meadow seedings arise from deep placement of the seed in the soil than from any other single cause. Under some conditions, early spring seedings may be broadcast on the surface when freezing and thawing of the soil can be relied upon to give proper coverage. When the seeds are planted ½ in deep or more in unmulched soil, the stand is reduced considerably. Sufficient research has been done to indicate that meadow seeds should not be planted at depths greater than ¼ to ½ in.

Much has been accomplished in regard to the relative placement of fertilizer and seed for row crops. Only recently, however, have we recognized the same problem with meadow seeding. Excellent results have been obtained by placing the seed from one to two inches above the fertilizer, and not more than ½ in to either side. This method, known as "band seeding," places the fertilizer in the most desirable position for availability to the young seedlings. It also removes the nutrients from weeds growing between the seedling bands.

Firming the soil around the seed is important. It is a recognized fact that moisture around both the fertilizer and seed affects their performance. For that reason, firming the soil *lightly* above and below the seed aids in the movement and retention of water. To aid emergence of the seedling, and to prevent a hard crust from forming, the immediate soil surface should be left loose. Designing a machine to meet these field operating requirements is a difficult matter. Nevertheless, it behooves us as engineers to strive to meet those critical requirements. They are basic.

Pasture Renovation. The function of pasture renovation is to improve the structural condition of the soil, to establish favorable nutrient balance and to add improved species to an already existing sod without complete destruction of established species, for purposes of increasing quality and quantity of pasture production.

Plowing under all vegetation actually falls within the realm of pasture establishment, as the same methods apply for tillage, seeding and fertilizing.

Destruction of the entire surface vegetation, a practice on which many authorities agree, is done to eliminate competition for plant nutrients to give the new meadow seedlings a fair chance for survival. At the Ohio Agricultural Experiment Station considerable work has been done in renovating hill pastures of low productive capacity by what is known as mulch seeding. A surface mulch is prepared from the existing vegetation to prevent soil erosion.

Mechanized methods for destroying and disintegrating the vegetative mass ultilize disks or field cultivators. In some instances the stubble pulverizer has been used for refinement of the mass after initial disking or cultivating. This assures better performance in fertilizing and seeding which is usually done in the conventional manner.

At the University of Wisconsin much success has resulted from the use of wide sweeps set in such a manner as to cut the existing sod into ribbons or bands. By operating these units at depths of approximately 3 in, all deep roots are severed to retard growth. The ribbons or bands of sod are then disintegrated by means of a disk, followed by normal fertilizing and seeding practices.

Partial eradication may be accomplished by slitting the soil or by processing narrow bands of predetermined spacing. Much has yet to be done, however, on (1) depth of fractured bands, (2) spacing of processed bands, (3) localization of seed and fertilizer, and (4) plant species best adapted to conditions.

For the seeding of most legumes *(Continued on page 798)*

Abridged paper presented before a meeting of the Pennsylvania Section of the American Society of Agricultural Engineers held at Pennsylvania State College, April, 1952.

The author — EDWARD A. SILVER — is a research and development engineer with the New Holland Machine Division, The Sperry Corp.

AUTHOR'S NOTE: Acknowledgment is made of the help and cooperation of G. K. McCutcheon and A. M. Best, New Holland Division, The Sperry Corp., J. A. Slipher, Ohio State University, and R. E. Dudley, Mississippi State College, in the preparation of this paper.

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Replications in Research

(Continued from page 792)

In Fig. 2 the same data are plotted as means of four combinations of duplicate tests. If only the data from replications C and D were available, one might well conclude that there was probably no real difference in draft between the three disks. It is apparent, however, from the other data available that this would not be a sound conclusion.

In Fig. 3 these data are plotted as means of four combinations of three replications. Here the merit of the increased number of replications becomes evident. There is considerable similarity among all four sets. All have the same direction of curvature, a curvature typical of speed-draft graphs. In all cases there is no crossing of the graphs for the different disks.

Finally, the same data are plotted in Fig. 4 as means of the four replications. By combining the data from the four replications the graphs for the three plows are more uniformly spaced and the curvature is still more typical of speed-draft data. Statistical analysis indicates a "significant" difference between the data for the highest and lowest graphs.

Two more replications would have undoubtedly given a still more satisfactory set of data and probably would have shown a statistically significant difference among the data for all three disks.

Improvement of Pastures

(Continued from page 796)

and grasses this method would not seem to hold much promise. Serious inaccuracies would occur in the depth of placing fertilizer and seed. There would be competition for plant nutrients by the existing species.

At the Mississippi Agricultural Experiment Station considerable work has been done to determine the best cultural practices for seeding and fertilizing oats in permanent pasture to supplement winter grazing. The method involves slitting the soil vertically by means of thin openers. For the purpose of placing the fertilizer and seed in their respective position, two openers have been used, one following the other. The front opener, set to operate from 3 to 6 in deep, deposits the fertilizer, while the rear opener, set to operate from ½ to 1 in deep, deposits the seed. A later design provides for single openers but with two channels through which the seed and fertilizer travel separately.

CONCLUSION

Factors in pasture improvement imposing functional requirements on machines used in this work may be summed up as follows:

1 To maintain and establish pastures, apply liberal applications of fertilizer and lime to sustain rapid growth, and in turn to promote a high state of soil tilth.

2 Prepare a fine but firm seedbed, for new meadow seedings.

3 Cover legume and grass seeds not more than ½ in, ¼ in preferred.

4 Localize fertilizer below seed for availability to young seedlings.

5 Use the most desirable species for conditions at hand.

6 To avoid competition for new meadow seedlings, destroy all vegetation for renovation purposes, except when seeding oats or other vigorous growing grasses to supplement seasonal grazing.

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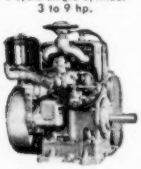
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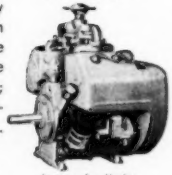
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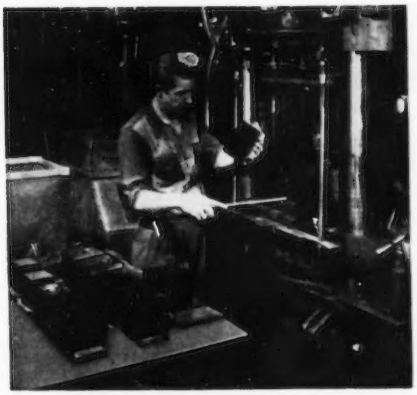

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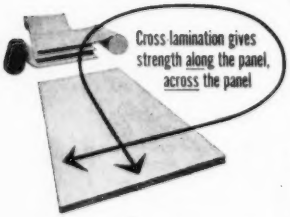

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BUMM, LEONARD M.—Farm representative, Pennsylvania Power & Light Co., Shamokin, Pennsylvania.

EWERT, F. C.—Supervisor, specifications and standards dept., Deere & Co., Moline, Ill.

FARRELL, THOMAS E.—Sales engineer, Dayton Rubber Co., Dayton, Ohio.

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HANSON, ELDON G.—Head, agricultural engineering department, New Mexico A. & M. College, State College, N. Mex.

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Years of production experience and close engineering cooperation with leading engine manufacturers, combined with modern high-volume facilities, enable Eaton to furnish high-quality valve seat inserts to meet the specific requirements of the automobile, truck, and tractor industries. The range covers all types, from low-priced, volume production inserts up to large-size, puddled-face inserts of suitable materials for large heavy-duty installations. A unique method of puddling special facing materials on insert seats enables Eaton to furnish inserts with superior corrosion and wear-resistant qualities at minimum cost.

You can utilize Eaton's long experience in this field by giving our engineers an opportunity to work with yours in the early stages of design.

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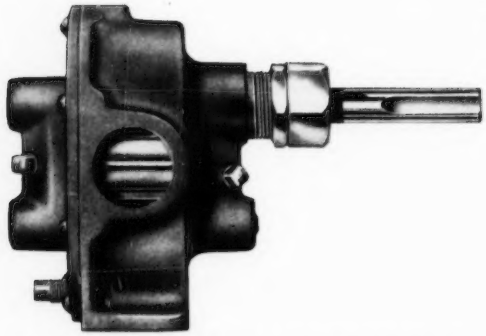
PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers



$100,000 BONUS
to users of
OBERDORFER
PUMPS

To improve the quality of our bronze spraying pumps, we have spent this year over $100,000.00 on complete redesign and purchase of vastly more accurate and efficient tools and fixtures for the machines which turn out our pump parts. When assembled, these interchangeable parts comprise Oberdorfer Bronze Metering Pumps which more than ever warrant their reputation as *the world's standard* for agriculture.

Improved quality may be measured in any pump by increased length of satisfactory service life. Oberdorfer agricultural pumps of 1953 *will last from 2 to 5 times longer than their predecessors.*

Moreover, because of greatly increased sales, we anticipate *no increase in the cost to you of these longer-lasting pumps.* This is our third successive year without any price increase.

To those few manufacturers of spraying equipment not presently using Oberdorfer all-bronze pumps, we suggest that if you elect to remain competitive, you will eventually buy Oberdorfer—and that increased quality and unchanged prices make 1953 a good year to start.

Drop us a note for the details of our 1953 designs and prices.

Agricultural Pump Div., Oberdorfer Foundries, Inc.
14212 Thompson Rd., Syracuse, N. Y.

OBERDORFER BRONZE SPRAYING PUMPS

NEWS SECTION

ASAE Meetings Calendar

December 15-17—WINTER MEETING, Edgewater Beach Hotel, Chicago, Ill.

January 20—MINNESOTA SECTION, University Farm Campus, University of Minnesota, St. Paul, Minn.

January 23 and 24—NORTH CAROLINA SECTION, Reddick Auditorium, Raleigh, N. C.

February 9-11—SOUTHEAST SECTION, Roosevelt Hotel, New Orleans, La.

February 14—MICHIGAN SECTION, Edison Boat Club, Detroit, Michigan.

March 7—OHIO SECTION, New Idea Farm Equipment Co., Coldwater, Ohio.

April 10 and 11—SOUTHWEST SECTION, Oklahoma A. & M. College, Stillwater, Okla.

April 23 and 24—PENNSYLVANIA SECTION, Agricultural Engineering Bldg., Pennsylvania State College, State College.

June 15 to 17—46TH ANNUAL MEETING, Hotel William Penn, Pittsburgh, Pa.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Michigan.

Dimmitt New Chairman Pacific Northwest Section

T. KARL DIMMITT, farm service director, Puget Sound Power & Light Co., Seattle, Wash., was elected the new chairman of the Pacific Northwest Section of the American Society of Agricultural Engineers at the Section's regular yearly meeting held October 30 and November 1 on the campus of the Oregon State College at Corvallis. He succeeds Jesse E. Harmond.

During the business session of the meeting four new vice-chairmen were elected as follows: 1st vice-chairman, T. L. Coulthard, assistant professor of agricultural engineering, University of British Columbia, Vancouver; 2nd vice-chairman, M. H. J. Miller, president and general manager, Anderson-Miller and Poston Mfg. Co., Spokane, Wash.; 3rd vice-chairman, L. J. Smith of Seattle, now retired, but for many years head of the agricultural engineering department at the State College of Washington, and 4th vice-chairman, Deane Booster, the student branch representative. The new secretary of the Section, elected at the same meeting, is R. S. Tait, manager of the Rain Bird Sprinkler Mfg. Co. at its Canadian headquarters at Vancouver.

The Section area comprises the three states of Washington, Oregon and Idaho and the Canadian provinces of British Columbia and Alberta. All areas of the section were well represented at the meeting. The parent society was represented by its president, Ivan D. Wood, collaborator between the Soil Conservation Service (research division) and the Extension Service, U.S. Department of Agriculture, with headquarters at Denver, Colo.

Extension Committee Meeting

A SPECIAL meeting has been arranged by the Committee on Extension of the American Society of Agricultural Engineers for all extension personnel in conjunction with the forthcoming ASAE Winter Meeting. The meeting is scheduled for Tuesday evening, December 16, at 8:30 in the Lincoln Room of the Edgewater Beach Hotel.

The latest techniques in visual education will be demonstrated and discussed by Mr. B. A. Jones of the Ethyl Corporation. All extension agricultural engineers and their extension associates are cordially invited to attend.

Hawaii Section Names Officers

OFFICERS for 1953 elected at a meeting of the Hawaii Section, American Society of Agricultural Engineers, on November 17, were Warren Gibson, chairman, and Loyd E. Bloomquist, vice-chairman. Lawrence W. Larson was re-elected secretary-treasurer.

The program featured reports from agricultural engineers affiliated with the Hawaiian Sugar Planters Association Experiment Station. Chairman Richard A. Duncan introduced A. K. Hansen, E. R. Bolles, Charles Hart, and William E. Hart. These gentlemen discussed and showed pictures, movies, and sketches of machines they had designed and used in sugar production.

J. P. Fairbank, regional director, Agricultural Extension Service, University of California, spoke briefly. He brought greetings from the division of agricultural engineering of the University at Davis.

(News continued on page 804)

Whether your needs are rims, gear blanks, rings, hoops, bands or other circular parts, you can get them *all* custom-made to your specifications at Cleve-Weld.

Because these parts are *mass-produced* on Cleve-Weld's special equipment, you benefit by substantial savings on each part—and tremendous overall savings on your needs for a complete job.

Cleve-Weld's engineering facilities, skilled workmanship and pre-tested materials are a triple-guarantee that you get the finest circular parts and rims on the market. Cleve-Weld follows your specifications with hairline accuracy... and when speed is essential, as it usually is, Cleve-Weld can deliver in every detail.

Just send us blueprints on your production requirements for rims and circular parts and we'll quote you the facts and figures.

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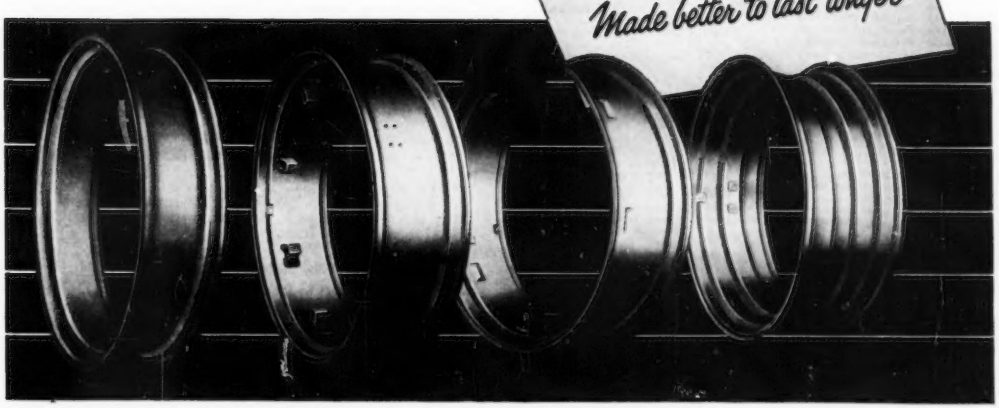
Made better to last longer

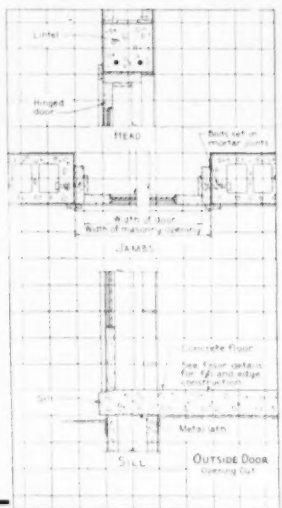


Now Available—

CONSTRUCTION DETAILS for CONCRETE FARM STRUCTURES

Because concrete is so widely used for all types of farm structures, it is important that all construction be thoroughly practical and all details structurally sound. The Portland Cement Association is presenting a series of 33 construction details that will be especially helpful to all agricultural engineers who make up farm building plans. All details are printed on 8½ x 11 sheets, suitable for tracing. They are made up in a scale (1½ in. to 1 ft.) which is widely used for details for windows, doors and other building parts.

The illustration at the right is a greatly reduced reproduction of Drawing No. Z-185 showing the construction details for framing an outside wooden door in a concrete masonry wall. The table below lists the other 32 subjects on which construction details are now available.



WRITE FOR THE DETAILS YOU NEED

Make a list of the details that will be helpful in your work and send it in today. Detail sheets will be sent free. Address Dept. 12-1.

OTHER DETAILS AVAILABLE

FOOTINGS
Z-45 For 8" Wall
Z-47 For 12" Wall
Z-49 For Wood Post
Z-50 For Steel Column

FLOORS
Z-136 On Gravel Fill
Z-135 With Moisture Proofing
Z-137 With Edge Insulation
Z-138 With Edge and Underside Insulation

WALL DETAILS
Z-225 Metal Window
Z-226 Wood Frame Window
Z-227 Insulating Glass Panel
Z-228 Glass Block Panel
Z-186 Outside Door—Opening In
Z-187 Sliding Door
Z-188 Removable Panel Door Frame
Z-460 Offset Lintel—2 Bar and 4 Bar Reinf
Z-461 Square Lintel—2 Bar and 4 Bar Reinf
Z-462 Steel Angle Lintels—Flush and Offset
Z-285 Cornice—Gable Roof
Z-286 Cornice—Gothic Arch Roof
Z-287 Cornice—Gambrel Roof
Z-390 Piers and Pilasters
Z-391 Control Joints

VENTILATION
Z-450 Fresh Air Intake
Z-451 Slot Ventilator
Z-452 Ventilating Louver
Z-453 Exhaust Fan

BARNYARD PAVING
Z-473 Construction Joint
Z-474 Dummy Joint
Z-472 Cut-off Wall
Z-471 Raised Edge
Z-470 Thickened Edge

PORTLAND CEMENT ASSOCIATION
33 West Grand Avenue, Chicago 10, Illinois
A national organization to improve and extend the uses of portland cement and concrete . . . through scientific research and engineering field work

NEWS SECTION (Continued from page 802)

Georgia Section Meets

SEVENTY-FIVE agricultural engineers and their guests attended the fall meeting of the Georgia Section of the American Society of Agricultural Engineers held at Radium Springs near Albany, Ga., on Nov. 14.

Following the opening remarks of Section Chairman John T. Phillips, Jr., and a welcome by J. I. Davis, Sr., Bill Blount of the Georgia Power Company spoke on highway life insurance. E. V. Komarek, manager of the well-known Greenwood Plantation near Thomasville, discussed the place of corn in southern agriculture and the challenges the production of this crop offered to the agricultural engineers of the Southeast.

J. I. Davis, Jr., demonstrated a new type planter and fertilizer distributor of his design particularly adapted to southern pasture development. L. H. Abersold, Opekasit, Inc., a firm supervising many thousands of acres in southwest Georgia, closed the morning session with remarks on the role of the agricultural engineer in farm management.

Part of group attending meeting of ASAE Georgia Section at Radium Springs on November 14. Left to right, F. A. Kummer, J. I. Davis, Jr., R. H. Driftmier, Geo. B. Nutt, and J. T. Phillips, Jr.

Presiding at the afternoon session was R. H. Driftmier, head of the division of agricultural engineering, University of Georgia. George B. Nutt and Fred A. Kummer, heads of the departments of agricultural engineering, Clemson Agricultural College and the Alabama Polytechnic Institute, respectively, spoke on the contributions of agricultural engineers to the agricultural and general economic development in their two states. The session closed with a forum consisting of an informal question and answer period based on the days talks. Participating in the forum were all the program speakers.

Climaxing the successful day's meeting was an evening social hour and barbecue on the patio of Radium Springs Casino.

Better Farm Buildings Dinner

TEAMWORK of the agricultural college, the farm building industry, retail sales outlets and the farmer in speeding up the design of more efficient farm structures will be emphasized in a panel discussion to be sponsored by the Better Farm Buildings Association during the Winter Meeting of the American Society of Agricultural Engineering in Chicago this month.

For the second consecutive year, the Better Farm Buildings Association, of which the ASAE is a member, will sponsor a dinner and panel discussion on the first day of the ASAE meeting, according to W. Everett Lakin, BFBA president.

Panel participants will be H. J. Reed, dean of agriculture, Purdue University; R. H. Driftmier, head, agricultural engineering department, University of Georgia; Charles Walte, Jr., director, Reynolds Farm Institute; Gordon Lawler, managing editor, *American Lumberman*, and Roy Battles, The National Grange. J. F. Schaffhausen, Johns-Manville Corp., will be moderator.

The dinner will be held in the Edgewater Beach Hotel at 6:30 p.m., Monday, December 15. Tickets will be placed on sale shortly. Reservations can be made through the president or any other member of the Better Farm Buildings Association.

Concrete Pipe Association Meetings

CONCRETE Pipe Associations, Inc., recently announced meetings of three member associations to be held at Dallas, Texas, in the period February 25 to 28.

The American Concrete Pressure Pipe Association is to hold its 4th annual convention February 25. It will be followed on February 26 by the third annual meeting of the American Concrete Agricultural Pipe Association.

(News continued on page 806)

The Uni-Harvestor, a Minneapolis-Moline development, includes the Uni-Combine, Uni-Husker, and Uni-Picker-Sheller attachments with the basic carrier.

Triple-duty Fafnir Ball Bearings

In selecting bearings for the revolutionary new Uni-Harvestor, Minneapolis-Moline looked for three essential characteristics. *First* . . . full protection against dust, dirt and moisture. It was found in Fafnir *Mechani-Seal* Ball Bearings, specially designed to keep contaminants out — grease in. *Second* . . . extra support for shafts like those on the cylinder and auger. Fafnir Wide Inner Ring Ball Bearings were chosen because they're engineered to give greater support to machinery parts . . . and, at the same time, be easily installed. *Third* . . . bearings with a reputation for years of trouble-free service were a "must" for this new development that offers such long-range possibilities. Again, Fafnir Ball Bearings met the exacting requirements of Minneapolis-Moline.

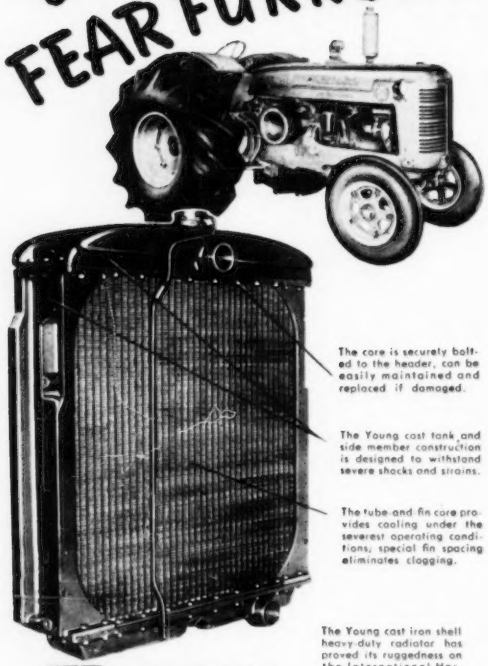
In the final analysis, however, something more than just good ball bearings was involved . . . the invaluable Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint . . . and an aptitude for providing the right bearing to fit the need. Perhaps this combination can help you solve bearing problems as successfully. The Fafnir Bearing Company, New Britain, Conn.

Fafnir Flangette . . . easier to install . . . costly machining eliminated.

FAFNIR
BALL BEARINGS

THE MOST COMPLETE LINE IN AMERICA

THE RADIATOR THAT DOESN'T FEAR FURROWS


The core is securely bolted to the header, can be easily maintained and replaced if damaged.
The Young cast tank and side member construction is designed to withstand severe shocks and strains.
The tube-and-fin core provides cooling under the severest operating conditions; special fin spacing eliminates clogging.
The Young cast iron shell heavy-duty radiator has proved its ruggedness on the International Harvester 9-series wheel tractors.

YOUNG

BUILDS RUGGED RADIATORS THAT COOL THE JOB AND CUT MAINTENANCE COSTS

It will pay you to investigate the advantages of the Young Agricultural Radiators. The combination of a *new* type core; cast iron tank and side members with reinforcing at the points of greatest stress assures International Harvester customers proper cooling and long life for the 9-series steel or rubber-wheel tractors.

Young Sales Engineers will be pleased to show examples of Young engineering and production solutions to problems similar to yours. Write us today.

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Heat Transfer Products for Automotive and Industrial Applications.

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NEWS OF ASAE MEMBERS

C. E. Everett Honored on Retirement

C. E. EVERETT retired October 31 on completion of 35 years of service with the Massey-Harris Co. Since February, 1943, he had served the company as general consulting engineer.

At a banquet in his honor on November 11, at Racine, the Company presented to him a gold model Clipper Combine and tractor on a 10 x 20-inch marble base, symbolizing one of his notable engineering contributions. An inscription on the base reads: "In his thirty-five years of active service for our Company, Mr. Everett's engineering genius and creative ability have contributed significantly to the advancement of harvesting throughout the world." Remembrances from groups of Mr. Everett's associates included an electric shaver and a pair of binoculars.

Between 1907 and 1917 Mr. Everett worked independently on several machine designs which were later incorporated in Massey-Harris equipment. Then the Company employed him as general field tractor engineer. In 1937 it advanced him to chief engineer of its harvester division, and for a period during World War II gave him an additional assignment as acting tractor engineer.

Mr. Everett has been a member of ASAE since 1938. His indicated plans for the future include an extended vacation in Oregon.

• • •

WALLACE ASHBY, head, farm buildings and rural housing division (BPISAE), U.S. Department of Agriculture, was recently elected by the Council of ASAE to the grade of Fellow in the Society, in response to a petition signed by ten Fellows of the Society. Mr. Ashby has been a member of ASAE since 1916 and was elected a Life Member of the Society in 1950, having fulfilled the provision of the Society By-Laws for life membership status.

• • •

FRED E. BECKETT recently joined the agricultural engineering staff of Louisiana Polytechnic Institute, at Ruston, as assistant professor. He was formerly test engineer with the General Electric Co.

• • •

THOMAS P. CHRISTEN, JR., who has been serving his company, Standard Oil Company of Ohio, for the past five years as agricultural engineer in the department of sales engineering, was recently promoted to manager of farm sales. He graduated from Ohio State University in 1947 and served 3½ years in the U.S. Army as a field artillery officer. He is currently the chairman of the Ohio Section of ASAE.

• • •

ARTHUR G. FOX recently joined the New England Electric System as assistant director of agricultural development. In this capacity, assisting F. L. Rimbach, director, his work will cover all companies in the system in the four New England States in which it operates. He will serve as technical consultant on all problems in rural electrification, for rural service men of the system, farm customers, county agents, extension men and others. He was formerly assistant professor of agricultural engineering at the University of New Hampshire. He is a native of Maine, a graduate of the University of Maine, and a veteran with war service in the Army Signal Corps, in the China-Burma-India Theater.

• • •

CHARLES W. GEELAN recently entered employment in the Corps of Engineering, U.S. Army, and moved from Normangee to La Marque, Texas. He was formerly in agricultural and civil engineering work with the Soil Conservation Service.

• • •

LESTER F. GEORGE was recently appointed instructor in agricultural engineering at the University of Maryland. Since his graduation from Pennsylvania State College in 1951 he had been associated with the standards department, Belleville plant, New Holland Machine Div., The Sperry Corp.

• • •

B. K. SINGH JAIN, assistant agricultural engineer, Volkart Bros., Kanpur, India, has been granted special leave by that organization to enable him to accept a fellowship at the University of Melbourne. He expects to go to Australia early in 1953. The fellowship is provided by the Australian Government under its commonwealth technical cooperation plan. It provides for two years of graduate study leading to master of science degree in agricultural science, based on some specific problem in agricultural engineering.

• • •

PHILIP W. MANSON is on leave from his position in the agricultural engineering division of the University of Minnesota to accept a four-months assignment with the Food and Agriculture Section of the United Nations. He will be engaged in setting up an agricultural engineering curriculum for the Hebrew Institute of Technology at Haifa, Israel.

• • •

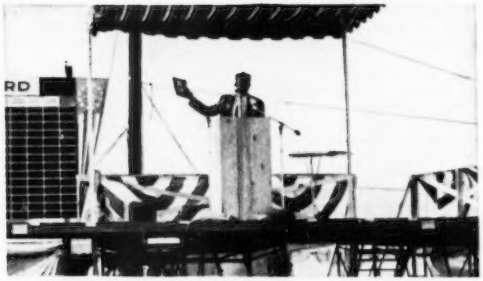
WILLIAM F. MILLIER has resigned as a member of the agricultural engineering staff of the University of Minnesota to accept appointment to a position in farm power and machinery work on the agricultural engineering staff at Cornell University, Ithaca, N. Y.

(Personals continued on page 808)

there's a **JOB** to be done

Here's How They Did it!

at KASSON



Morris Fonda, President of the Soil Conservation Society of America, welcomed the crowd over the public address system and didn't forget to put in a plug for "Down the River."

Politics was on everyone's tongue at the National and Minnesota Soil Conservation Day and Plowing Matches at Kasson on September 5 and 6. After all, it's not every year that you can look at, as well as listen to, both presidential candidates on the same day.

But this added attraction for 1952 was not permitted to interfere with the regular schedule of events. The crowd of over 100,000 came to see state and national plowing matches of both level land and contour varieties PLUS a demonstration of soil and water conservation in many of its most important phases—and see it they did—on foot and horseback, from the air, and especially by hitching rides on the dozens of flat-bed wagons pulled by farm tractors which toured the 1100 acres of the six participating farms, stopping at many points on the route to hear technicians explain exactly what was going on.

There's a job to be done, and it won't be finished until urban people as well as rural people understand what total Conservation and proper Land Use is all about and what it means to each of us. What the tens of thousands saw at Kasson is a definite and important step in that direction.

The weather, both days, was clear and cool, but 1100 is a lot of acres and the touring wagons never lacked customers.

Austin-Western Power Graders Made Themselves Generally Useful

Constructing terraces

Building waterways

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SINCE 1859—BUILDERS OF CONSTRUCTION EQUIPMENT

NEWS OF ASAE MEMBERS

(Continued from page 806)

JACK R. MORRIS has resigned as mechanical superintendent, Olaa Sugar Co., Olaa, Hawaii, to accept appointment as a farm machinery specialist with the Point IV agricultural mission of the Technical Cooperation Administration, U.S. Department of State, in Iraq. Mr. Morris is an agricultural engineering graduate of the University of California, and prior to going to Hawaii about four years ago, he was in the employ of the U.S. Department of Agriculture and stationed at Davis, Calif.

• • •

ARTHUR E. SCHWANTES is on leave as chief of the division of agricultural engineering, University of Minnesota, to accept an assignment under the TCA program at Cairo, Egypt. His position is that of farm machinery specialist, and the activity is under the administration of the American Embassy in Cairo. His duties are to give assistance to the Ministry of Agriculture and other officials of the Egyptian government in the development of a farm machinery program with the objective of organizing an efficient maintenance and repair service and a machinery training program for operators, conducting demonstrations on utilization of farm equipment, and stimulating interest in better types of machinery and hand tools, which includes help in improving designs of native implements and miscellaneous machinery. He will be on leave until September 1953, and possibly until some time in 1954.

NEWS SECTION (Continued from page 804)

Also starting February 26 and continuing through February 28 will be the 45th annual convention and meeting of the American Concrete Pipe Association.

All of these meetings are to be held in the Baker Hotel. Further information may be obtained from Howard F. Peckworth, managing director of the associations, 228 N. La Salle St., Chicago, Ill.

AAAS Bows to Engineering

"THE Contribution of Science and Mathematics to Engineering and Industry" will be the general theme of the program for the annual meeting of the American Association for the Advancement of Science, December 27 to 30, at St. Louis, Mo.

According to information received since announcement of the meeting in AGRICULTURAL ENGINEERING for November, the AAAS meeting will be a part of Washington University's centennary and officially the final event of the Centennial of Engineering.

Sectional programs and symposiums and the AAAS Science Theater are to be located in the Kiel Auditorium, adjacent to a large annual Exposition of Science and Industry.

A session on "The Nation's Nutrition: From Soil to Cytoplasm" will emphasize chemical and biological aspects of food production. (Agricultural engineering phases of carrying this science into application on a production scale are omitted from the items to be considered.)

Related organizations scheduled to meet during the conclave include the Scientific Research Society of America and Sigma Xi.

A human significance approach to engineering interests in the meeting is suggested by titles to individual contributions such as "How Can We Fit the Machine to Modern Man," "Man as a System Component," and "Industrial Efficiency Is National Welfare."

Dairy Engineering Conference

THE first annual dairy engineering conference will be held February 25 and 26, 1953, on the campus of Michigan State College at the new Kellogg Center, to discuss the engineering features of dairy plant operation and design, and also dairy equipment design. The conference is being sponsored jointly by the departments of agricultural engineering and dairy in cooperation with representatives from the various groups from the dairy industry.

The purpose of the conference is to permit an exchange of ideas on dairy equipment which will be beneficial and of interest to the dairy plant engineer and dairy equipment designer from the standpoint of more efficient utilization and design of equipment. Possibilities of developing new equipment to improve the processing operation will be discussed.

The material is to be presented from an engineering standpoint but should be of interest to dairy plant superintendents and managers as well. Plans are being made for the discussion of the following major subjects by outstanding authorities in the industry: (1) refrigeration plant design and operation, (2) steam boiler operation and selection, (3) efficient operation of ice cream freezers, (4) plant design layout and time and motion studies, (5) building design and materials of construction, (6) cleaning equipment and accessories, (7) water treatment for dairy plants, and (8) engineering challenges in the dairy industry.

For further information and a copy of the program, write to the Department of Agricultural Engineering, attention Carl W. Hall, Michigan State College, East Lansing, Mich.

Outstanding Opportunity

FARM EQUIPMENT ENGINEERS

Harry Ferguson, Inc., leading tractor and farm implement manufacturer, is embarking on a vigorous program of engineering expansion and has openings for competent engineers, primarily designers and draftsmen.

Applicants must be mechanical or agricultural engineering graduates, or have equivalent farm machinery background. We are interested in men with experience, but recent graduates with farming background will be considered.

Competent engineers have full opportunity for an interesting and profitable career and will experience working with some of the finest engineers in the country. Excellent working conditions plus many employee benefits. Salary open.

If you would like to become associated with this young and progressive company, write a letter outlining your experience and background.

Write to:

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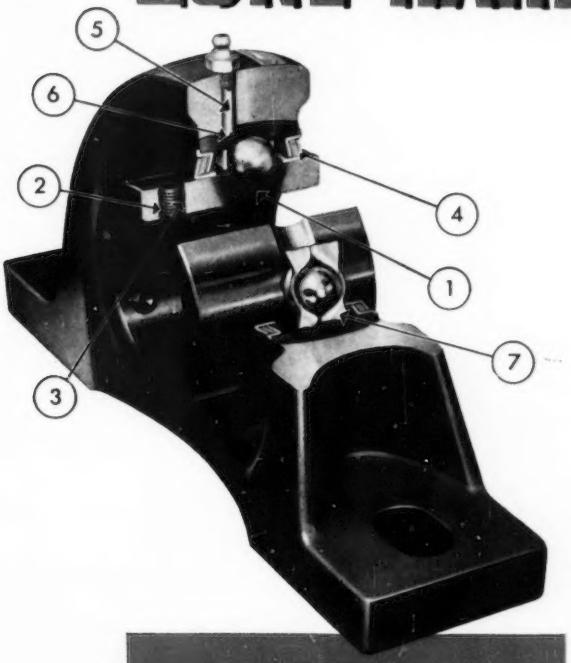
Box 322
Detroit 32, Michigan

Interviews are now being held in various parts of the country convenient to the applicant.

SEALMASTER *Ball Bearing Units*

With ZONE HARDENING*



ZONE HARDENING is a completely automatic heat treating process by which the inner race ring of SEALMASTER Ball Bearing Units is hardened—through the ball path section only! (See 1 in cutaway view.) The extended part of the inner race is left in its original metallurgically soft tough state. Hardened set screws are mounted through this soft portion of the race (See 2 and 3), permitting race-to-shaft locking with increased holding power and greater resistance to shock and vibration. Firm lock of bearing to shaft minimizes danger of fretting corrosion and eliminates shaft wear.

SEALMASTER first introduced the self-aligning, permanently sealed, industrial ball bearing unit . . . the outer race locking pin . . . the ball retainer riding the inner surface of the outer race ring—and now Zone Hardening—all patented features!

SOME IMPORTANT SEALMASTER FEATURES

PERMANENTLY SEALED, SELF-ALIGNING BALL BEARING
. . . has felt-lined steel flingers rotating in labyrinth to prevent entry of dirt and to retain proper amount of lubricant (see 4).

LOCKING PIN AND PERIMETER DIMPLE
. . . prevents bearing from spinning in its housing and prevents fretting corrosion between housing and bearing, yet permits sufficient shaft alignment without seal distortion (See 5 and 6).

BALL RETAINER
. . . rides on the ground inner surface of the outer race ring (See 7), eliminates ball wear, trapping grease and preventing its churning in the bearing.

SEALMASTER Units are available in many special housings as well as in the complete standard line. Write us for full details on special units. Ask for a copy of SEALMASTER Catalog 845.

*Patented—exclusively SealMaster's

SEALMASTER BEARINGS

67 RIDGEWAY AVENUE, AURORA, ILLINOIS

A DIVISION OF STEPHENS-ADAMSON MFG. CO.

FACTORY REPRESENTATIVES AND DEALERS IN ALL PRINCIPAL CITIES

FOR FARM AND INDUSTRY

ELECTRIC

WHEELS ARE RIGHT

Over 65 years in wheel manufacturing have given us the "know how"—modern production methods assure long life and efficient wheel performance in the field.

There is an ELECTRIC spoke or disc wheel for most types of portable equipment. Axles are available where required.

Our experienced engineers are ready to assist you in solving your wheel and axle problems and we will offer our recommendations upon receipt of your specifications.

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the BADGE of him who BELONGS

DESPITE the *presumption* it sets up, mere membership in the American Society of Agricultural Engineers is no *proof* of a man's high rank in technical talent. It does prove that he has met certain minimum requirements and has earned the esteem of colleagues who sponsored his application for membership.

But the Society emblem is *evidence* that native talent, be it great or small, is enriched by fraternity with the personalities whose minds fuse to form the pattern of progress in the methods and mechanics of agriculture. The wearer of the emblem waits not for the debut of an idea, but is present at its birth and helps to guide its growth.

Be you novice or veteran, your membership in the organized profession adds something to your efficiency, your vision, your influence as an individual engineer. The Society symbol on your lapel is token that you "belong". Wear it.

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NEWS FROM ADVERTISERS

New Products and Literature Announced by AGRICULTURAL ENGINEERING Advertisers

Engineering Data on Caps and Filler Necks

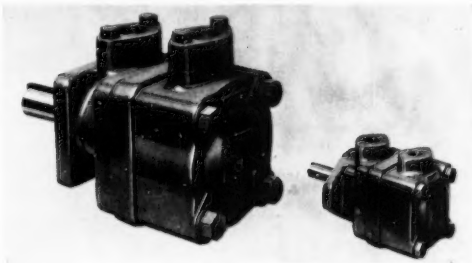
A booklet of engineering data on the standard line of "Easy-On" caps and related necks now available in stock for immediate delivery, has been issued by Eaton Manufacturing Company. This on-the-shelf supply will be of major interest to designers and manufacturers of fluid tanks, radiators, oil filters, etc., for prime movers, tractors, construction machinery, air compressors, power mowers and similar equipment. Blueprints of all stock numbers are available upon request. Copies of this booklet and additional information are available from Eaton Mfg. Co., Stamping Division, 18001 James Couzens Highway, Detroit 35, Mich.

Nickel-Containing Alloys for Permanent Magnets

International Nickel Co., Dept. EZ, New York 5, N. Y., has issued a 16-page bulletin with the above title, containing 8 graphs, and listing sources of supply in the United States for nickel-containing permanent magnet alloys. This booklet reviews the commercially available permanent magnet alloys, especially the Alnico family. Advantages and limitations of these are high-lighted. Characteristics of ductile permanent magnets (cunife and cunico) and of special permanent magnets (silver and platinum alloys) are described. The booklet contains a table giving representative magnetic properties and composition of 23 alloys. Copies will be sent on request direct to the Company.

New Vane-Type Hydraulic Motors

A new line of oil hydraulic vane motors was recently announced by Vickers, Inc. Of rugged construction and utilizing heat-treated alloy steel for shaft, rotor and vanes, the motors are built to work under difficult service conditions. Design features also favor long life at continuing high efficiency and low maintenance cost. An exclusive rocking-beam construction keeps all vanes in intimate contact with the cam ring at all times, yet is not subject to the fatigue-failure difficulties of spring-type vane actuators. A combination of low inertia of moving parts and automatic wear compensation for both radial and axial clearances contributes to high performance efficiency throughout the life of the motor. Mounting adaptability is provided by a choice of four combinations of inlet and outlet port positions, and choice of flange or foot mounting and either direct, belt, chain or gear drive. Vickers vane-type hydraulic motors are now available in two series, M2-200 and M2-500, for 5.0, 6.5 and 26-hp output. Intermediate sizes are being developed. Engineering and installation data are available in Bulletin No. M-5102 direct from Vickers, Inc., 1516 Oakman Blvd., Detroit 32, Mich.



Vickers' new vane-type hydraulic motors

PROFESSIONAL DIRECTORY

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RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to ASAE members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

Ask for G-E Motors and Control on all Electrified Farm Equipment you buy!

GENERAL ELECTRIC FarmNews

Ask for G-E Motors and Control on all Electrified Farm Equipment you buy!

MORE POWER TO THE AMERICAN FARMER through more electricity on the farm

CROP DRIER BEATS WEATHER...SAVES GRAIN!

Heated-air drying lets farmers harvest early... lowers crop losses, brings in top market prices

Manager Williams adjusts back-draft damper to protect hens from incoming drafts.

VT. FARMERS FIND ELECTRIC VENTILATION PAYS OFF

Milk and egg yields are increased, farm building rot is checked

Keeping the air in barns and hen houses fresh and dry is important up in Vermont, especially during the long, hard winters. Here is how two farmers do it.

Healthier flocks, more eggs

Robert O. Williams, manager of Mrs. J. H. Huyck's poultry farm at Wells, Vt., keeps his 500 pullets and hens comfortable, and laying well, with two electric-powered ventilating fans.

Egg production is excellent since the two fans were installed, Mr. Williams notes. His hen house is cleaner-smelling, and he doesn't need to change the litter nearly as often. Further, he estimates that the hen house will need less repairs because structure-rotting moisture and ammonia are almost eliminated.

Power for the two fans is provided by G-E motors. Check "Poultry House Ventilators" on the coupon for more information.

Dairy herd produces more milk

"Some of the best money we ever spent," say Leland and Edward Congdon, Clarendon, Vermont, of the two-fan ventilating system they installed in their dairy barn.

Their 60 head of cows and calves stay healthier because humidity is kept low and sudden changes in temperature are eliminated. Milk production is increased because cows eat more and drink more.

Walls and floors in their 95-year-old barn stay dry. Rot, which was destroying the hay chutes has been checked.

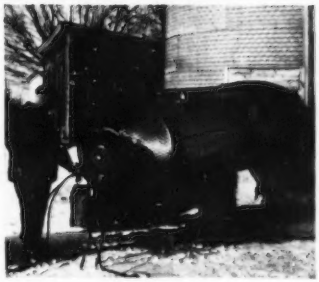
Both of the ventilating fans are equipped with G-E motors for quiet, dependable operation. For more information, check "Electric Ventilator" on the coupon.

"Thanks to the drier, my income will increase by at least $1300," reports Mr. Clare Backus of Route #1, Charlotte, Michigan, who recently leased a modern portable crop drier. "My first 800-bu. crib brought in $1350. That was a premium price, because the corn was early and because the cob was bone-dry. I will get at least that much for the second 800-bu. I dried."

Saves half his corn crop

"By using the crop drier, I saved half my corn crop this year," continues Mr. Backus. "The second crib would have spoiled if I had waited for the old-fashioned natural air drying process. Despite damp weather, the drying process took less than 50 hours."

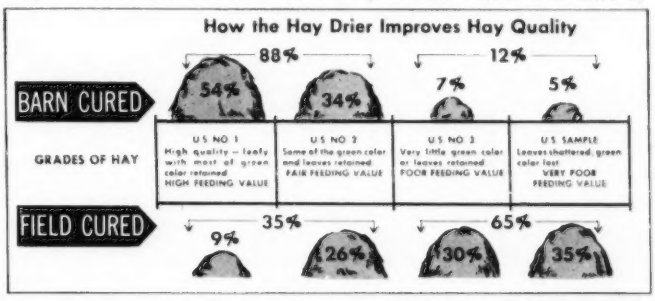
Mr. Backus saves other ways, too. He can start harvesting early, while moisture content is high. He can operate his combines more hours per day. He doesn't need to turn the grain to cool it. And there is no danger of the corn getting moldy if he wants to hold it on his farm until the market is more favorable.



Clare Backus adjusts valve on crop drier. Hot air is blown through corn, expelled through vent at top of crib.

Hay is improved, too. It stays green, leafy and fresh when it is dried by forced-air, and it keeps the natural sweet smell and flavor that always disappear after it has been long exposed to sun and weather.

To assure dependable, automatic drier operation, the manufacturer selected a 5-hp General Electric motor, and G-E controls. For more information, check "Crop Drier" on the coupon.



Barn haydrying with a crop drier improves hay quality by keeping it green and leafy.

Congdon points out how rot, which was destroying the hay chutes (photo at left) has been practically eliminated by moisture-reducing ventilating fans.

General Electric Company
Section 671-24D, Schenectady 5, N. Y.

I would like additional information on the following equipment.

- ☐ Crop Drier
- ☐ Dairy Barn Ventilator
- ☐ Poultry-House Ventilator
- ☐ How To Choose Your Motor

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If yours is a special irrigation problem, consult our research department now.

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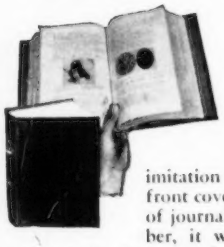

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Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN—APRIL—O-603-568. MAY—O-619-570, 630-572. JULY—O-712-575. SEPTEMBER—O-741-581. OCTOBER—O-767-583, 767-584, 770-585, 770-586, 760-588, 782-589, 783-590, 785-591, 758-592, 778-593, 786-594, 744-595. NOVEMBER—O-824-596.

POSITIONS WANTED—APRIL—W-582-109. JUNE—W-678-121. JULY—W-694-123, 691-124. AUGUST—W-721-129, 694-131. SEPTEMBER—W-735-133, 739-134. OCTOBER—W-762-136, 769-137, 765-138, 775-139. NOVEMBER—W-793-141, 791-142, 792-143, 823-144, 810-145.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEERS (2 openings) for sales work with wholesale distributor of a diversified line of farm equipment items, including irrigation equipment. Michigan and/or Indiana territory. BS deg in agricultural engineering or equivalent, with thorough knowledge of farming, and farm equipment. Some sales experience required. Other business experience desirable. Neat appearance, good personality, ability to mix well. Ambition and interest in earning maximum commission. Opportunity for advancement. Age 25-45. Salary and commission $6000-12000 range. O-797-597.

PROJECT ENGINEER for design and test of farm equipment, either tillage or harvesting, with manufacturer west of the Mississippi River. Engineering degree and 2 years or more experience in farm equipment design, testing, or related work. Should be able to organize design and test program, and willing to travel. Opportunity for advancement with progressive, expanding organization. Age 22-35. Salary $4800-6000. O-875-598.

DESIGN ENGINEER with experience with hay equipment desired by well established California firm. Immediate opening. Degree desirable but not required. Salary open. O-876-599.

NEW POSITIONS WANTED

ENGINEERING or agricultural development, service, teaching, writing, or part-time writing in irrigation, soil and water, or power and machinery field, with industry, preferably in Brazil or neighboring country. BS deg in agricultural engineering, 1949, A & M College of Texas. Soils testing and soil and water research engineering since graduation. Veterans' teacher 4 mo. Pregraduation experience with experiment station and packing company. Married. Age 25. No disability. Available on 30-days' notice. Salary $5000. W-843-146.

TEACHING, research, or writing in power and machinery or soil and water field with industry, any location. Willing to travel. BS deg in agriculture expected January, 1953, University of Florida. Experience as manager and operator of 400-acre farm in New York State one year, herdsman 8 mo, SCS part time aide, 6 mo. War non-commissioned service nearly 3 yr. Married. Age 28. No disability. Available February 15. Salary open. W-814-147.

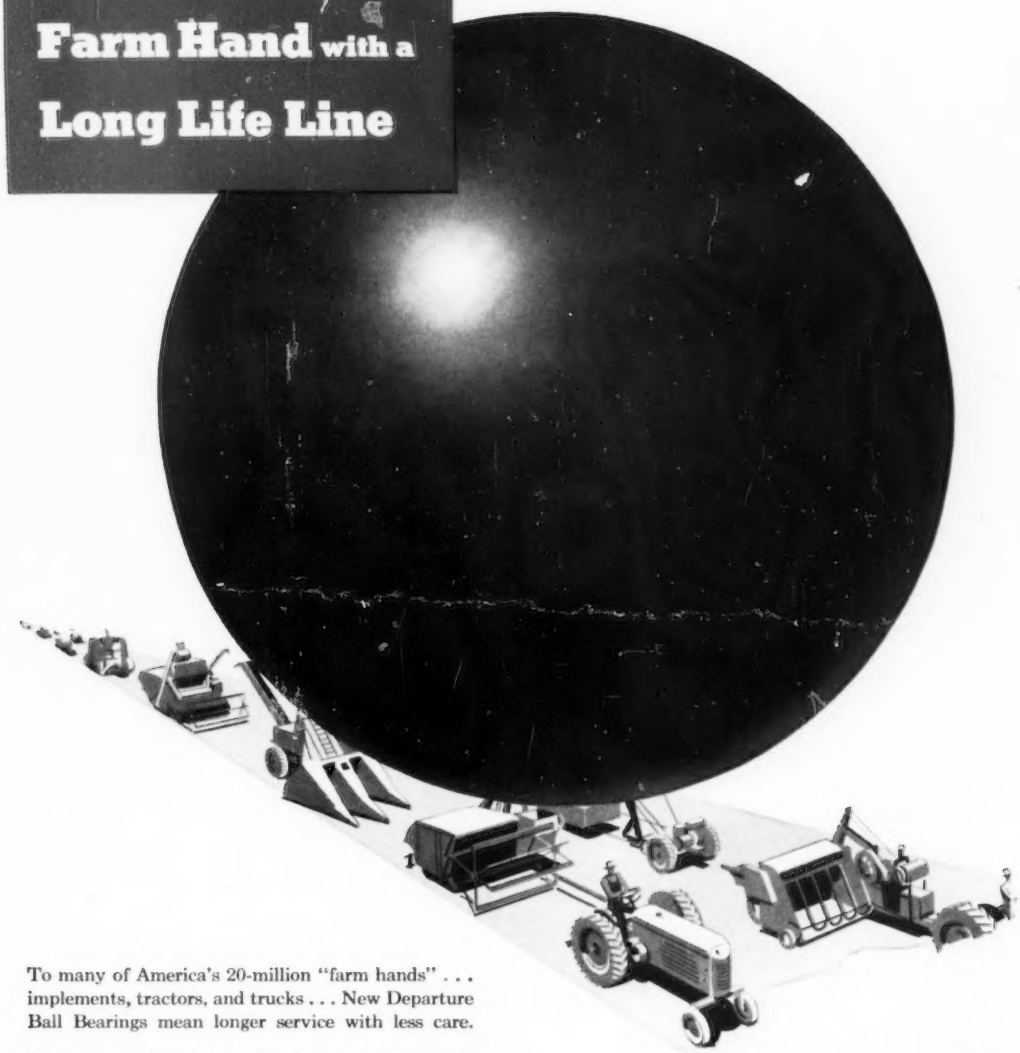
RESEARCH or extension in power and machinery or soil and water field with industry or public service, preferably in Southwest. BS deg in agricultural engineering, South Dakota State College, 1933. Some graduate study. Registered professional engineer in Texas and New Mexico. Extended engineering experience with SCS. War commissioned service in Infantry. Married. Age 44. No disability. Available January, 1953. Salary $6000. W-832-148.

DEVELOPMENT work in power and machinery field, with manufacturer or farming operation, preferably in Southeast or Mid-South. BS deg in agricultural engineering, 1949, Alabama Polytechnic Institute. Farm background. War non-commissioned service in AAF as flight engineer. Training period and more than one year as territory manager with farm implement company. Married. Age 30. No disability. Available March 1. Salary $6000. W-849-149.

DESIGN, development, research, or teaching in power and machinery field with industry or public service. West or Midwest. BS deg in agricultural engineering, 1949, MS, 1950, power and machinery major. Research, teaching, extension and administrative experience in agricultural engineering department of land-grant college, 2 years. Farm background. War non-commissioned experience in Medical and Signal Corps. Variety of pregraduation experience. Married. Age 29. Faulty vision corrected by glasses. Available July 1. Salary $5,500. W-866-150.

DEVELOPMENT, research, extension, teaching service, writing or management in power and machinery or rural electric field, with college, manufacturer, or distributor. Any location. BS deg in agricultural engineering expected December 19, South Dakota State College. Ohio farm background. Machinist, diesel engine factory 4½ years. Airplane mechanic 2½ years. Assistant power use advisor, rural electric cooperative, one summer. War non-commissioned service over 2½ years in Army Air Force. Able to talk and write. Interested in furthering education. Married. Age 29. No disability. Available December 20. Salary open. W-860-151.

Farm Hand with a Long Life Line



To many of America's 20-million "farm hands" . . . implements, tractors, and trucks . . . New Departure Ball Bearings mean longer service with less care.

Even greater life expectancy of farm machinery is now possible through the application of New Departure "Sealed-for-Life" Ball Bearings. With dirt sealed out and lubricant sealed in, they do not require further attention or adjustment. N-D-Seal bearings also simplify design problems and save money for the farm implement manufacturer because they conserve space and frequently require fewer parts.

Through its resources of research . . . its engineering excellence . . . its precision production . . . New Departure offers the farm field the finest. Keep your eye on the BALL to be sure of your BEARINGS!

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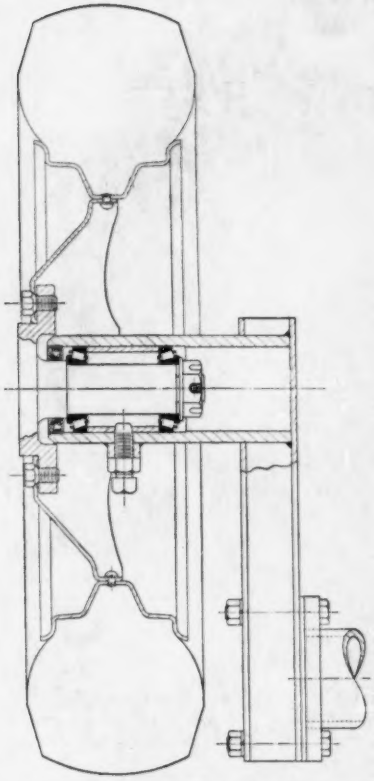
EVERY NEW FARM TRACTOR HAS TIMKEN BEARINGS; MORE AND MORE IMPLEMENTS ARE USING THEM, TOO!

Unique live-stub axle design gives Case shredder added strength at less cost



Timken bearing application on live-stub axle of Case stalk and vine shredder, another implement in which the agricultural engineer has solved three of his biggest design problems by using Timken bearings.

In this application, the Timken bearings are mounted so that the outer race is held stationary and the cone is the rotating race. Bearing life is increased by this mounting, cost reduced.

HERE'S the unique live-stub axle design used by J. I. Case engineers in their stalk and vine shredder. This design results in a stronger axle. And it lowers production costs.

One big reason: the axle is mounted on Timken® tapered roller bearings. Line contact between rollers and races gives Timken bearings load capacity to spare.

The live-stub axle design permits the use of smaller Timken bearings resulting in a more economical mounting.

Being tapered in construction, Timken bearings easily take the combination thrust and radial loads that occur in operation over rough terrain.

Dust and dirt are kept *out* of the bearings because Timken bearings keep housing and shaft concentric, making closures more effective.

In this Case shredder, as in hundreds of other implements and tractors, Timken bearings are helping agricultural engineers solve three of their biggest design problems—dirt, combination loads and ease of operation. And implement users are assured of longer implement life, less chance of breakdown on the job, less frequent lubrication, higher towing speeds.

Write for your copy of "Tapered Roller Bearing Practice on Current Farm Machinery Applications". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

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